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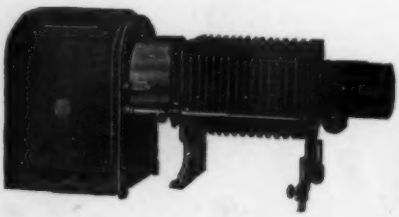

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XIX, NO. 7 OCTOBER, 1919 WHOLE NO. 162

CAMP ROOSEVELT: MAN MAKER.

By FRANK C. JACOBY,

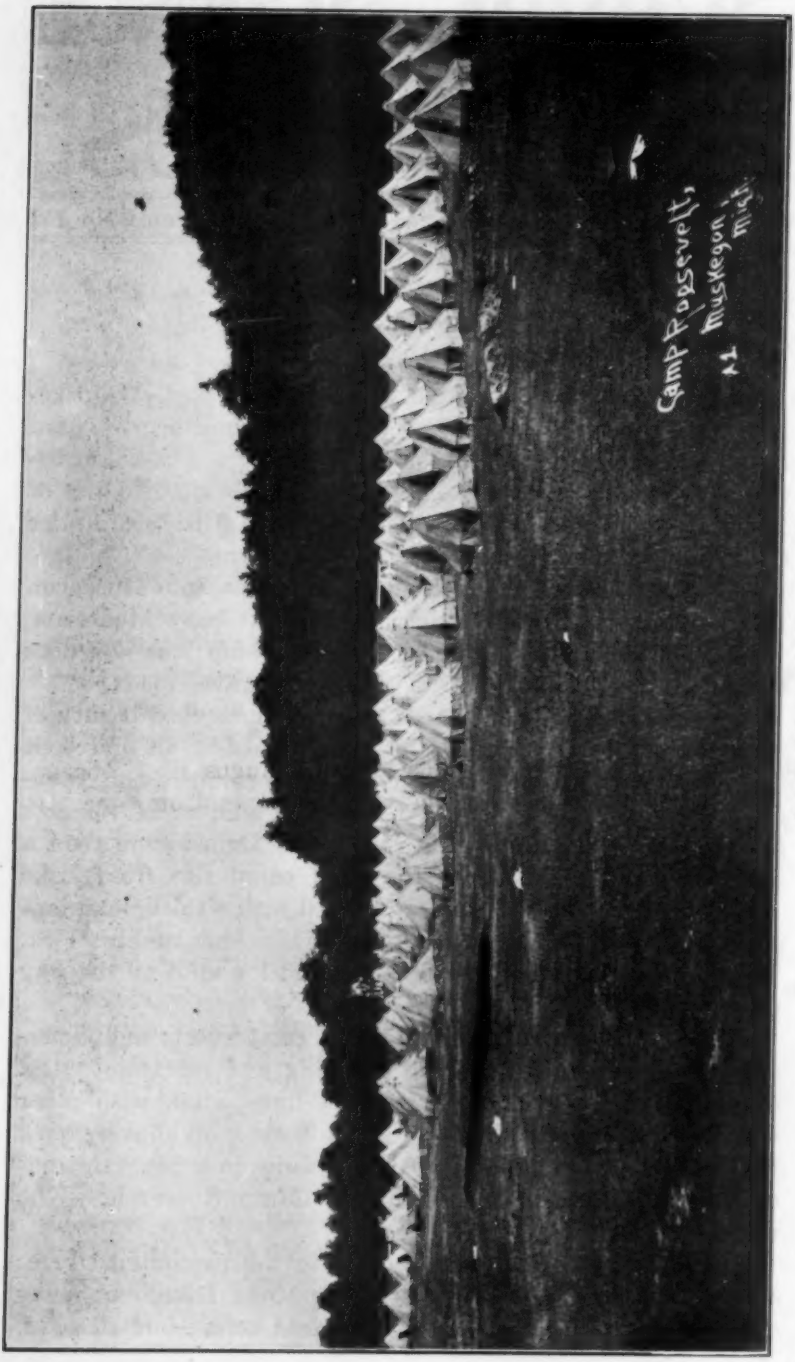
Englewood High School, Chicago.

As the steamer from Chicago, bound for the port of Muskegon on the east shore of Lake Michigan, steers northeast toward Lake Muskegon Channel, one may see dimly a depression between two thickly forested sand dunes. This is the outlet of Mona Lake, between whose waters and Lake Michigan nestles Camp Roosevelt, one hundred ten miles northeast of Chicago. The Goodrich "liner" glides through the channel into Muskegon Lake, and several miles further on docks at busy Muskegon, with its fifty thousand population. The camp 'bus line does the rest, for a distance of six miles over gravel roads.

One at first sight is entranced with the unrivalled beauty of the camp setting. Mother Nature fashioned it all and kept it in condition a million years till Camp Roosevelt came. Stevenson wrote, "The world is so full of a number of things": he must have had his eye on this spot. Dunes more than a hundred feet high separate the level camp site from Lake Michigan, every portion of them covered with a thick, luxuriant growth of timber—mainly beech, oak, white pine, and hemlock. There is no soil, no rock—sand only, and it's sand all the way down.

A master mind once projected here a great resort; and numerous cottages, bathing facilities, winding and romantic paths, a tunnel (or was that tradition?), a huge hotel, with other marks of bigness, came into life at the beck of an alluring bank balance. A cry of "fire!"—the vision fades in ashes. But out of the ashes sprang the Phoenix of Camp Roosevelt. Who made it spring?

Here is a level area, snuggled up to the precipitous dunes on the west and stretching east along Mona Lake, embracing old apple orchards, a goodly six hundred acres—but all sand,



View of Part of the Tents.

mind you—no mud. A particularly suitable part of this campus is about fifteen acres closest to the hills, used as parade ground and for the score of daily activities. Here, too, are grouped the buildings: headquarters, commissary, officers' and teachers' lodgings, "Y" hut, canteen, mess stores, mess halls for officers and cadets. There are also the tents for school office, hospital, dispensary, band, visitors, Knights of Columbus, and Y. M. C. A., and one hundred seventy-five for the cadets, scoutcrafters, sergeants, company and battalion commanders.

Captain Frank L. Beals, U. S. A., head of the military department and supervisor of physical education of the Chicago schools, discovered this place of such natural charm and conceived of Camp Roosevelt. Prince of fellows, born leader, he took up the job where nature left off. His organizing ability, linked with a constructive imagination, wrought out this auspicious beginning. What shall be the end? Who can juggle the horoscope to tell the sweep of a really great idea?

Camp Roosevelt stands for something entirely new: it is the only military high school in America.

Captain Beals allied with himself in the Camp Roosevelt Association a group of Chicago and Muskegon people—big-hearted, forward-looking folk, with large interest in the project. Then he enlisted the support of the war department. That's the core of his backing. Such men as Angus S. Hibbard, consulting engineer of the Chicago Telephone Company, as chairman of the Executive Committee, show upon what sound and enduring basis this great camp is founded.

And his idea was nothing short of this: military, athletic, social, religious, and academic education for boys. With such basic principles he would found a great summer school for R. O. T. C., scouts, and scoutcrafters.

What is the attitude of the war department toward the enterprise? I append a clipping from the camp News:

Colonel F. J. Morrow, General Staff, Washington, D. C., and chairman of the Committee of Education and Special Training, in a letter to Angus Hibbard, chairman of the Camp Roosevelt committee, compliments Mr. Hibbard, Captain Frank L. Beals, commandant, Camp Roosevelt, and the committee on the excellency of the work at Camp Roosevelt this summer.

The letter was a reply to a report Mr. Hibbard filed with Colonel Morrow in reference to Camp Roosevelt following his former visit here two weeks ago.

The letter is of special significance because Colonel Morrow, in unquestionable terms, clearly states the benefits of Camp Roosevelt.

Colonel Morrow is very familiar with the Junior R. O. T. C. work as carried on in Chicago, because he personally inspected the high schools and their military work last spring.

Officers of Camp Roosevelt.

The nine men at the right in front row belong to the High School Faculty. The group at the extreme left are Y men, the rest, Military and Physical men. Capt. Beals standing under A.

Here are the big points of his letter:

1. You and your associates have demonstrated the unquestionable value of summer training.
2. It is a potent influence for the benefit and welfare of young manhood.
3. Your accomplishment is on a par with that which General Wood developed at Plattsburg.
4. It is a contribution to the potential national strength and defense.

More than that, Colonel Morrow in person inspected the camp, August 26-27, and issued his pronouncement upon it in most satisfactory terms.

Let me produce the testimony of another member of the General Staff, Major General William G. Haan, as director war plans division and assistant chief of staff. In a letter to Mr. Hibbard he writes:

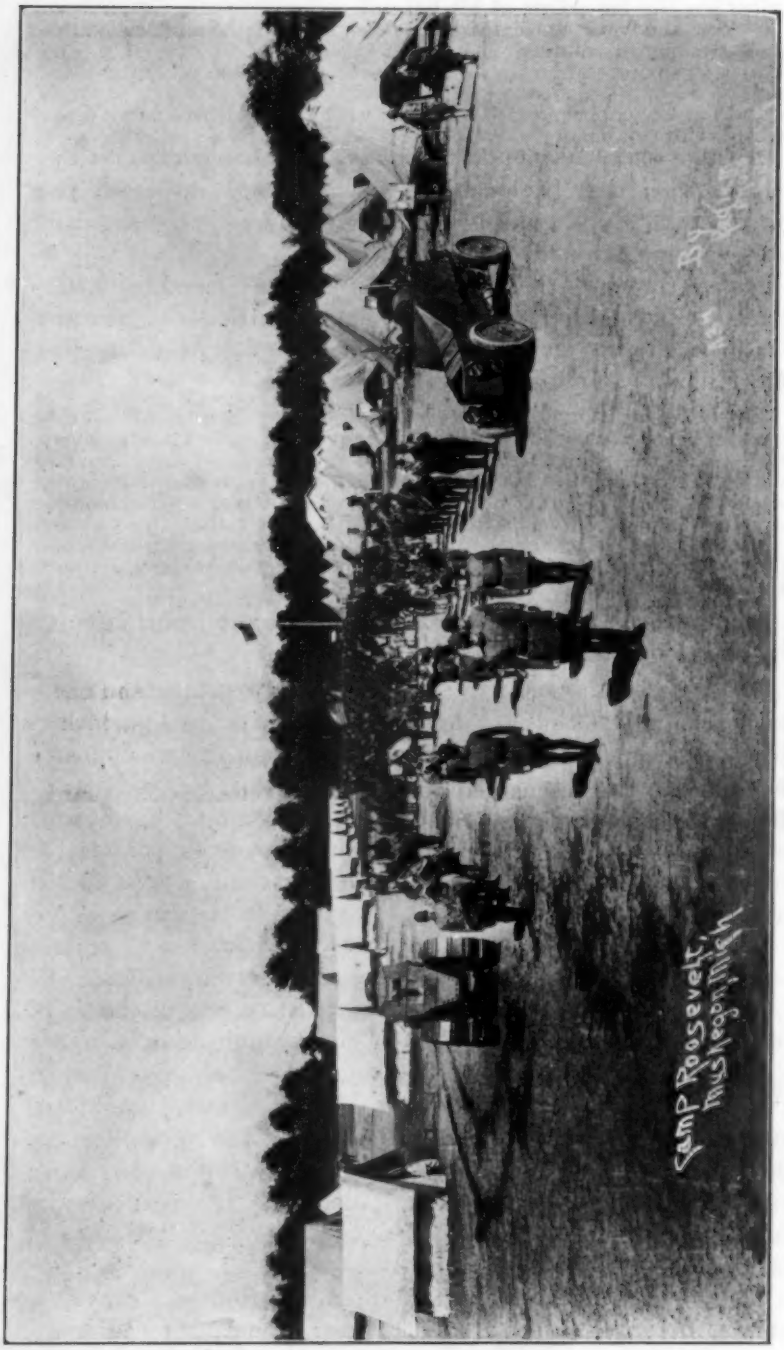
> The project at Camp Roosevelt has aroused very general interest and approval in the war department, and its unqualified success has been very gratifying to me. That a camp organized and conducted along the lines followed there can become an effective means of implanting in our youth the soldierly ideals of patriotism, clean living, and wholesome discipline has been conclusively proven. It is felt that these camps are deserving of the war department's unfailing encouragement and approval, and that the future years will see them again in operation with increased attendance and success.

These utterances make clear that the project looms large to the General Staff at Washington.

The cost need be but little in excess of transportation and one dollar a day for food; the high school tuition is to be added. The Chicago board of education secured from the war department the free use of all such equipment as tents, cots, mattresses, packs, kits, uniforms, shoes, and guns. The term, beginning early in July, is divided into two-week periods for military training; while the eight weeks' attendance in full is required for high school credit.

The plan for the high school and the acceptance of its credits has been approved by Superintendent Mortenson and the Chicago board of education. The instruction was in charge of ten specially selected men from Chicago high schools, under Principal Charles H. Smith, assistant principal of the Hyde Park high school and Editor of School Science and Mathematics. Mr. Smith has the give-and-take, the robustness, the democratic touch, the happy faculty to warm up to people, that fits him for this important leadership. His peerless wife has found a place in the affection of the boys as "Mother of the Camp."

The courses numbered thirty-seven, distributed thus: history and civics, seven; Spanish, three; French, three; botany, one; zoology, one; physics, one; chemistry, two; English, five; Latin, six; mathematics, seven; aviation, one.



Line-Up for a Review.

Nature has furnished a most ample laboratory for zoology on the low-lying shores of Lake Mona; the flora for botany is exceedingly rich and varied. Hence, field excursions were a frequent occurrence.

The Muskegon high school gave, without cost, its laboratory three times a week for the science classes. This was but one of many exhibitions of the cooperative spirit of the people in that city.

The school routine ran: 8 to 9 a. m., study; 9 to 12, four periods, two to each subject. Students might carry but two courses. The school used the mess halls and had real blackboards. But the project for 1920 is ambitious—a sure enough school plant of special one-story design.

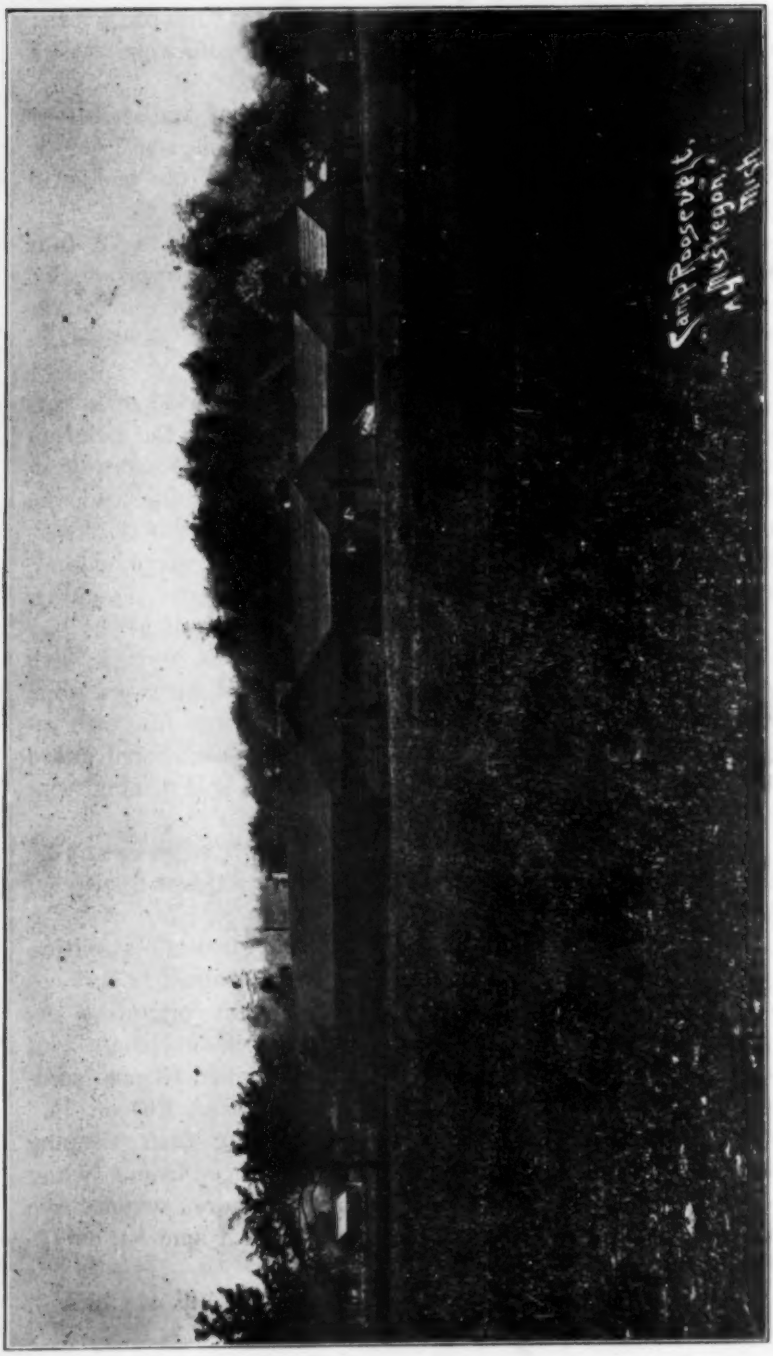
The enrollment this year after but a short period of advertisement was 172, with fifty-three additional in the aviation branch. Next year, all competent judges agree, more than four hundred will seek this cool, picturesque nook for academic credit. The membership came from fifty-two schools in sixteen states, eleven east and five west of the Mississippi, extending from Florida to Minnesota and New York to Wyoming.

If any other camp has stood for the development of the boy —the whole boy—in the directions undertaken here, I have not heard of it. The military was cared for by twenty-one regular army officers, sixteen regular army sergeants, two reserve officers, two discharged officers and seven national guard officers, the latter acting as physical directors and coming from the Chicago schools.

The total attendance at the camp was 2747, representing 26 states. This is proof positive that the camp has already gripped the attention of the whole country.

The religious and moral welfare was given adequate attention by the Y. M. C. A. and the Knights of Columbus; in services conducted by both Catholic and Protestant organizations; in meetings of the "Hi Y" Club, and in personal contact of boys and "Y" men; for one "Y" man is assigned to each company of cadets as its special friend and adviser. Fifteen "Y" men contributed their whole time, including their sleeping hours, to the joys of the boys. These joys ranged from a penny box of matches to a Ford loaded with one hundred seventy-five pies. ("Lizzie" was the honest-to-goodness friend of everybody.)

The "Y" leadership rested on Dr. Don D. Tullis of Chicago,



View of the six School Buildings and Mess Halls.

a broad-gauged, trained, resourceful man—truly a find for this man's job.

The national administration never appropriated nine thousand dollars more purposefully than that to Camp Roosevelt. This expenditure will have some improvements to be set down as permanent assets: There is the large 30 by 84 hut with its offices, its reading and writing facilities, its seating capacity for social, religious, and musical events; the boxing and wrestling stand and full equipment, all of standard style; the two wells, put down with characteristic "Y" dispatch in a day; and the complete out-of-door movie equipment on the sloping bank of the Mona channel. Doctor John R. Mott should see with his own eyes what his wisdom hath wrought.

The social nature got helpful stimulus from the "sings," the addresses by prominent speakers, band concerts, and the varied entertainments, consisting of stunts, vaudeville, jazz orchestra, and the lowly phonograph.

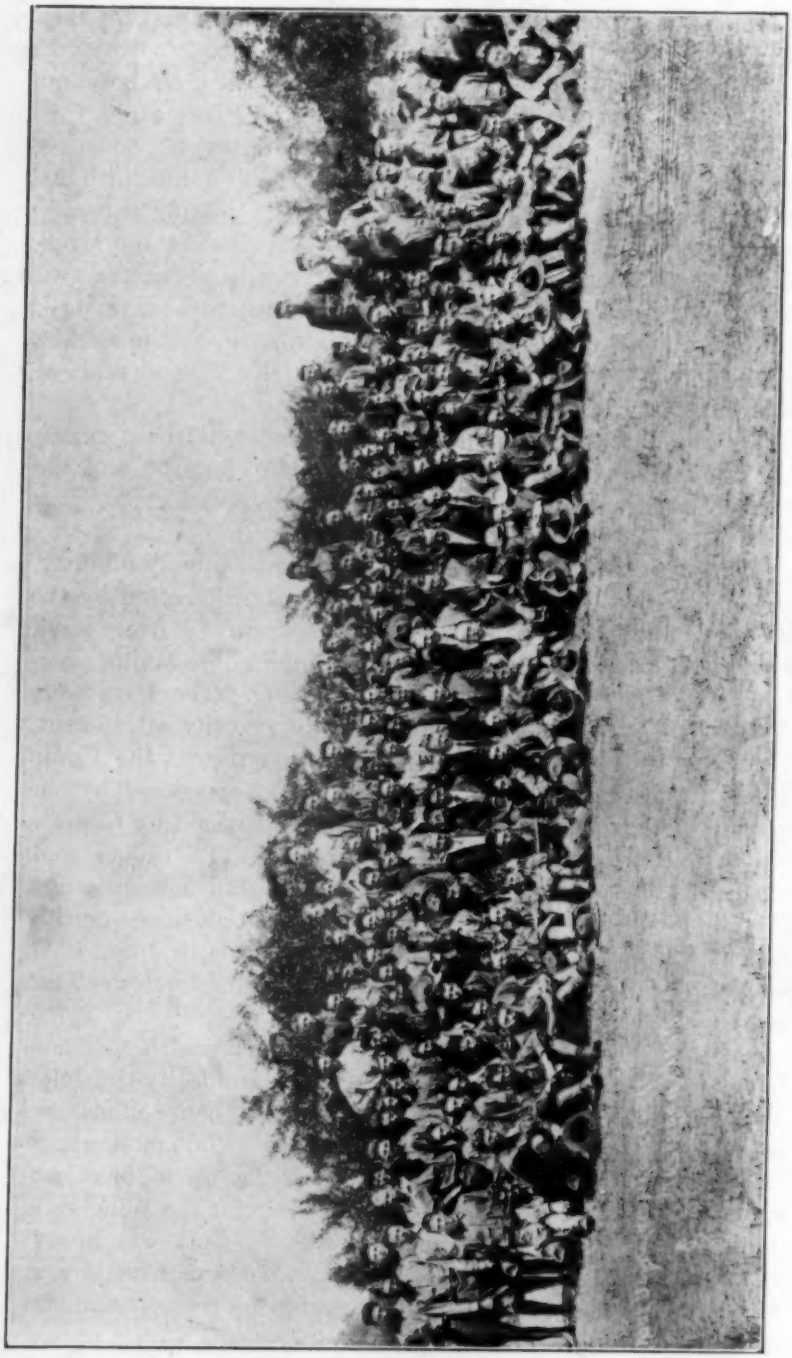
The physical had its full quota. Besides the purely military, there were the numerous activities which were directed by the group of physical education teachers: mass games of every kind, setting-up exercises each morning, swimming, life-saving practice, target practice, boxing, and wrestling. The boys were spurred on by the bestowal of medals for worthy attainment.

Among the popular agencies at the camp was the Camp Roosevelt News, published every Saturday, sponsored by the generous Muskegon Daily Chronicle, and managed by Captain E. R. Hoftyzer and Daniel P. Mitchell. The cadets took keenest interest in supporting its editorial and news columns. Nor did it die at the "taps" of camp, but it will continue monthly to boost Camp Roosevelt until reveille sounds in July, 1920. Captain Beals plans that it become the clearing house for Chicago high school news.

Then the military bands: The Lane Technical high school band, then the Chicago Daily News band, and lastly the Joliet Township high school band—premiers, all of them—ministered to our pleasure and put a cadence even into civilian step.

The steady crack of small rifles from flag-up to flag-down spoke for the place in the heart of the camp for the Winchester Junior Rifle Corps. Lieutenant Sidney A. Cort was always at the range to direct target practice. Scores of medals were won by proud cadets which were presented by the commandant with impressive ceremonies.

The Camp Exchange had one circumstance in common with



Part of Camp Roosevelt High School Boys and Faculty.

the State-Lake theatre: when open hours neared, the line-up was long and anxious and often went away penniless. There was no mistaking the sincere delight the campers felt in the stacks of wholesome goodies to be seen on the counters. Vive la canteen!

The word hospital originally meant "guest." Cadets, on the morning of a particularly fatiguing hike, grew suddenly very ill and became guests of Dr. W. S. Bracken. An expert in such cases, the doctor promptly administered a triple dose of castor oil. He and his three associates were at the free service of the camp each twenty-four uncomplaining hours. Patients that needed special attention were transferred by the motor

Bathing at Camp Roosevelt.

ambulance to the city, where no facility was lacking for their speedy recovery. The health of the camp was marvelously near perfect, barring the intestinal epidemic that swept the country and excepting the trifling matter of—green apples. Health Commissioner John Dill Robertson of Chicago was the director of the medical corps.

With the eye of the world upon this successful experiment and the increased support of the Chicago board of education and the war department at Washington, we are justified in looking forward to an institution here that shall have a far wider scope than to be the "West Point of Michigan." It will prepare men, not to kill, but to be obedient, loyal, high-minded Americans.

OLD AND NEW CLASSIFICATION.

By HENRY S. CONARD,
Grinnell College, Grinnell, Iowa.

Change of classification is an inconvenient necessity. But no one would cling to an outworn system merely on grounds of convenience. We all claim to be ready to change our system when a new and better one is worked out. It is much more difficult to recognize that a new system is better than an old one. All the force of habit, and all of our personal experience in organizing ideas for ourselves and for others tend to make us feel that an old system has, after all, such marked advantages of clearness and convenience as to make the old really better than the new. For a system of classification is nothing more than a summary of all our knowledge about the things classified, in convenient form for thought, teaching and research.

To the teacher, however, the value of the system to a pupil looms large in importance, and all of us older fellows must grant that a proper bringing up of the next generation is much more important than the temporary convenience of our own plans. How much we have all had to unlearn! Let us not place this same burden upon our successors. For the beginners of today have no prejudices in favor of any system of classification. We actually find our students absolutely open minded and receptive.

The bearing of these principles upon the classification of plants as found in current texts is very obvious. We have long been tied to a fourfold division of the vegetable kingdom: Thallophyta, Bryophyta, Pteridophyta and Spermatophyta. The groups seem to us remarkably easy and "natural." But in making these groups coordinate, we hide the deep affinities which bind the last three groups onto the old Archegoniatae, or the more recent Embryophyta. We find that students can learn just as easily as twofold division of plants into Thallophyta and Embryophyta. The many other advantages of such a division cannot be developed here.

Similarly the Embryophyta, instead of falling into the three accustomed phyla, separate just as readily in the mind of the beginner into the simple, ductless mosses, Atracheata, and the vascular series or Tracheata. The Tracheata are divided into Lycopsida and Pteropsida, for reasons too well known to need mention. These are the two most ancient and fundamental phyla.

Finally, the Pteropsidan series is made up of the seedless fern group (Aspermae), the Gymnospermae and the Angiospermae.

That the system outlined above comes as near as possible to presently accepted views on phylogeny, I suppose, will not be questioned. It has the logical advantage of almost complete dichotomy: Further, it emphasizes those characters which have undoubtedly been of greatest influence in determining the survival and superiority of each successive group. In synopsis the grouping stands thus:

Thallophyta
Embryophyta
  Atracheata Mosses
  Tracheata (Vasculares)
    Lycopsida
    Pteropsida
      Aspermae
      Gymnospermae
      Angiospermae

Experience with beginning students proves that this scheme is at least as easy as any other, and that it is more suggestive of the outstanding facts of plant structure and development. As it is essentially the system used in most modern botanical thought, may we not hope, by friendly criticism and correction, to get it promptly into shape for adoption and for presentation to our pupils?

Note—A somewhat extended presentation of this outline is about to appear in *The Plant World.*

AN IMPROVISED SPINTHARISCOPE.

By C. C. KIPLINGER,

Mount Union College, Alliance, Ohio.

In 1903 the great English scientist, Sir William Crookes, devised an instrument for demonstrating the presence of alpha rays which are given off by radium and other radioactive materials. He found that an alpha particle impinging on a crystal of zinc sulphide or hexagonal zinc blende gives rise to a flash of light and the alpha particle becomes a particle of helium gas. Hence, radium has the ability to change into another element, namely, helium.

The foregoing instrument, called the spinthariscope, is constructed as follows: A metallic needle carrying a bit of radio active salt is supported about one-eighth of an inch above a

small screen coated with phosphorescent zinc sulphide. This is held in place at one end of a short tube, the other end carrying a lens which is focused on the screen. When the screen is viewed through the lens, this operation of necessity taking place in a dark room so that the eyes may have become sufficiently sensitive to detect the faint flashes, the screen of zinc blende exhibits countless numbers of scintillations.

The spinthariscope costs several dollars, but the writer has found a satisfactory substitute, which is composed of an Ingersollite, a small tube containing a trace of radio-active material and a phosphorescent salt, mounted in a hollow cork at the focus of a one-half or one-quarter inch magnifier. The cost of the Ingersollite is twenty-five cents. The same effect is obtained by observing the tube in a dark room with a hand magnifier of short focus. Since ordinary light casues the phosphorescent salt to glow and a strong glow of this kind will mask the alpha ray effect, it is essential that the tube be kept in the dark for some time prior to the observation. The latter is best carried on at night, when the eyes are relaxed and far more sensitive to faint changes in luminosity.

The low cost of the above contrivance should make it possible for interested students to construct their own instruments, thus enabling them to study the above phenomena at their leisure.

SALT IN THE UNITED STATES.

The Delaware Indians made salt from brine springs in New York State and sold it to settlers as early as 1670, making probably the first commercial production of salt in this country. The manufacture of salt by white people in the United States was begun near Syracuse, N. Y., about 1788. Salt is the most commonly used mineral in the world, and no useful mineral except coal, perhaps, occurs in greater abundance or is more widely distributed in the United States.

The Federal and State Surveys and private establishments have published a great deal about the occurrence of salt in parts of the United States, but not until now has so much information on the salt deposits of the whole country been assembled in a single book. This book, which is entitled *Salt Deposits of the United States*, has just been issued by the United States Geological Survey, Department of the Interior, as its Bulletin 669, an illustrated volume of 275 pages, written by W. C. Phalen after he had visited many salt-producing localities from New York to California. In this volume the distribution and character of the salt deposits are described by states and a brief history of the industry is given, together with a record of the output since 1797. The report also contains a discussion of the origin and formation of saline deposits and many chemical analyses of brines and bitterns. This bulletin should be in the hands of everyone who is interested in the salt industry. It can be obtained free of charge on application to the Director, United States Geological Survey, Washington, D. C.

WHAT GRAPHICAL AND STATISTICAL MATERIAL SHOULD BE INCLUDED IN THE NINTH-GRADE MATHEMATICS COURSE?[1]

By L. E. MENSENKAMP,

High School, Freeport, Illinois.

The fact that the graph is a comparatively recent innovation in ninth-grade mathematics is well known. Not more than a decade ago there were in use in our secondary schools a number of algebras which made no use of it either in the elementary or the third-semester course. Other books of the same period accorded it some space in an appendix. In view of the fact that the graph is such a relatively new device in elementary mathematics, it is not surprising to note a considerable variation in the amount and kind of treatment which it receives in the current texts.

It is our purpose here to examine the different uses to which the graph has been put in high-school mathematics in order to determine, if possible, just what portions of this material are suitable for the ninth-grade course. We must consider the precise motives which lie back of the teaching of each piece of graphical work. Material of this kind should be taught, not because it is the prevailing fashion to do so, but because each part of it has some definite contribution to make to the pupil's mathematical equipment. In selecting the classes of graphs which can best be studied in the first year course, it is also well to bear in mind the fact that a large proportion of the students of such a course will not go on to the work in advanced mathematics.

We shall consider the different phases of our topic in the order in which it seems most desirable to have the student meet them in the classroom, that is, in the order of their relative difficulty. The type of graph which deals with the relations of certain empirical data is apt to have the strongest appeal to the beginner, and hence forms the most desirable introduction to the whole subject. Work of this kind has many possibilities because of the great variety of interesting statistical material there is to draw from. The pupil may plot data based on price-levels, growth of population, weather reports, insurance, and a great diversity of economic and social phenomena. The local Y. M. C. A. may be running a membership campaign, and the boys will be greatly interested in recording its daily progress

[1]Presented before the mathematics section of the Thirty-first Educational Conference of the University of Chicago, May 9, 1919.

on squared paper or on the blackboard. The progress of the recent Liberty Loans in a community would have afforded excellent opportunities along the same line. Or, if practice exercises are being used in connection with the mathematics course, it may be well worth while to chart the attainments of the class from day to day. Because of the increasing use which is being made of graphs of this kind in our newspapers, magazines, and books, it is quite unnecessary to say anything to justify a consideration of them in the first-year course.

Not only should the pupil be taught how to set up statistical curves from tabulated data and how to read from them the value of one variable corresponding to a given value of the other, but he should also be required to consider the other things which they teach us. In connection with a curve showing the relation between the temperature and the time, for example, he should be required to locate the highest and the lowest temperatures; he should be required to tell at what time the temperature is rising or falling most rapidly, and in what intervals it is most nearly stationary. He will then begin to appreciate the striking advantages which the pictorial method of representation has over a table of numbers, as a means of exhibiting the essential relations between two changing quantities.

Of course it is possible to overdo all this. The enthusiastic teacher could doubtless spend a whole semester plotting such statistical curves, but it would be exceedingly unwise to go too far in this direction at the expense of some other equally important, if not so attractive, branch of mathematics.

After enough work of the kind just outlined has been carried out to make the pupil thoroughly familiar with the technique of the squared paper, that part of the subject more closely related to the traditional content of mathematics should be taken up. The transition should take place gradually through the plotting of such simple mathematical relationships as those which exist between the cost of a certain kind of goods and the amount purchased, the relation between the cost of a railway journey and the distance traveled, or the relation between the simple interest on a given amount of money and the time. The pupil should also construct formulas for the above relationships and thus be brought to see the connection between the algebra and the graph.

Next, problems may be taken up which require the use of two lines on the same paper. The following is an example:

A has \$12.00 in the bank and starts to save at the rate of \$3.00 per week. B has no money in the bank, but at the same time as A, starts to save at the rate of \$4.00 per week. How long will it be until they have both saved the same amount? Here the money each has will be plotted against the time, and the solution will be found from the point on the time-axis corresponding to the intersection of the two straight lines. Many other problems can be devised which will depend upon the same method for their solution. The following is an illustration based on rates: A starts from a town at the rate of 5 miles per hour, and is followed 3 hours later by B, who proceeds at the rate of 7 miles per hour. How long will it take B to overtake A? Here, again, the answer is obtained directly from the graph.

Many books give no space to problems of this kind, but there is much to commend them to the attention of the mathematics teacher. They deal with the graph directly in relation to some concrete problem, and the student is impressed with this new way of expressing mathematical relationships as he never could be if the work were confined to the somewhat mechanical procedure of plotting abstract equations. The meaning of the problem is kept in the foreground, and serves as a constant check against many of those mistakes in locating points which occur when students try for the first time to plot equations of the type $ax+by=c$.

With the way thus carefully prepared, it is time to proceed to the more difficult matter of plotting pairs of simultaneous equations. The difficulties arise from a number of causes: Abstract equations are being plotted now; algebraic work of a more laborious nature is necessary to get the table of values; and negative numbers appear, making it necessary to consider all four quadrants of the plane.

Early texts often treated the graph as an isolated topic, but it is now recognized that it should be made an integral part of the exposition of the equation. It is clear that the main purpose of the graph here is not to serve as a device for the practical solution of equations—its defects for this purpose are obvious enough—but rather *to interpret and give a geometrical meaning to such systems of equations and their solutions.* When the pupil comes to associate the pairs of numbers which satisfy an equation in two unknowns with the points on a line, he sees at once why it requires two equations to obtain a unique

solution in such cases; he sees in a vivid way why pairs of equations may sometimes occur which are incompatible; and he sees why still other pairs of equations may have an indefinite number of solutions. Any treatment of the graph which fails to make these connections absolutely clear to the student must be futile.

We have next to consider the employment of the graph of the quadratic equation in the first course. Textbooks are not at all unanimous in introducing it here. It is not to be used as a means of solving the quadratic in one unknown, but rather as a means of interpreting geometrically the roots. From the graph the pupil perceives a new meaning in the fact that some quadratics have two real roots, others but one real root, and still others none at all.[2] If the conception of the use of the quadratic graph just pointed out is a correct one, the question of whether or not it should be taken up in the first course would seem to resolve itself into the other question of whether or not we are justified in discussing the number and nature of the roots of the quadratic at this early stage in the pupil's career. Since most, if not all, of the quadratics which the freshman will have an actual need of solving will have two real roots, and since there are so many other more important topics in the usual crowded ninth-grade course which demand thoroughgoing treatment, it seems, on the whole, to be advisable to defer any discussion of the number of roots—and, consequently, the quadratic graph—until the advanced course.

The discussion of graphs in the first course may now be summarized as follows:

(1) The first graphs to be considered should deal with statistical material of a type which will appeal to the pupil.

(2) A number of simple mathematical graphs based on *concrete* problems (e. g., problems related to savings or rates) should then be taken up, and their solution obtained directly from the graph. The relation between the graph and the formula may be emphasized here.

(3) Graphs of simultaneous linear equations should be considered because of their value in giving a meaning to the solutions.

(4) Graphs of quadratics are not essential to the first course.

[2]Any mention of *equal* roots or *imaginary* roots seems out of place in the first course. See the interesting remarks of Professor Huntington in *Monographs on Modern Mathematics*, edited by J. W. A. Young, pp. 153-155, also, p. 182.

DEVELOPING ABILITY TO SOLVE THE VERBAL PROBLEM: THE BASIC AIM OF THE NINTH GRADE COURSE.[1]

By ELSIE G. PARKER,
Oak Park High School, Oak Park, Ill.

The first speaker this afternoon called your attention to the fact that, whereas the prevalently used textbooks devote about eighty per cent of the time to work with the formal processes and only twenty per cent of the time to verbal problems, the tendency in four recently written books on "General Mathematics" is to reverse the emphasis, giving the greater amount of time to the verbal problem. As this means a radical change in our course of study we must examine the evidence carefully to determine whether or not such a change in emphasis is justifiable. To this end permit me to outline briefly the arguments presented by those who urge this new order of things. Then let us note what effect this change in emphasis will make in our actual classroom practice.

In the first place, careful investigation has shown that educators in general agree that the purpose of education is twofold, consisting not only of the giving of information, but of the development of the powers of purposive thinking or reasoning. This statement is based, not on the mere opinion of one or two persons, but on the statements of hundreds of teachers, carefully collected and classified by a committee of the North Central Teachers Association. This report shows that the teachers of any school subject place as their fundamental aim the development of the ability to reason, to think, to analyze, or some other phrase similar in meaning. We may start, then, with the premise that instruction in any high-school subject should be based on these two purposes of giving information and of developing the power to think. In the course in mathematics these fundamental aims may be stated more explicitly, as, first, the aim of developing ability to manipulate the formal processes, and, second, the aim of developing the ability to think logically.

Now, of these aims, that of developing the ability to think logically is asserted to be by far the more important. Not only are the more involved formal processes of algebra of minor use in high-school subjects, other than mathematics, as has been shown by statistical investigation, but the number of pupils

[1]Read before the Mathematics Section of the Educational Conference, the University of Chicago, May 9, 1919.

using them in the other mathematical courses in the high school is astonishingly small. This is due in part to the fact that the high-school population decreases rapidly after the ninth grade, and in part to the fact that a relatively small number of those taking the ninth-grade mathematics continue with courses beyond geometry. On the other hand, all persons, or at least all not engaged in the most routine work, continually face one new situation after another which calls for an analysis of its factors, a weighing of relationships, a comparison with former experiences, a survey of modes of attack, and, finally, some one of these carried out to a conclusion. Certainly, the power to think logically is the greatest asset in this case.

If, then, we may assume that the chief end of the ninth-grade course is to develop the power to think, certainly that part of the course which gives opportunity for such development should be the part emphasized. Does the formal material offer this training in logical thinking? That is, does drill on the formal processes develop one's reasoning power? None of us will deny that during the time when a formal process is being presented to the class, if presented not as a mere rule, but as a method of procedure with a reason behind it, a pupil does engage in the processes of reasoning. He will even reason his way through the first times he uses the new process, but soon the step becomes automatic or at least becomes a series of steps which are dependent upon memory. This is not a thing to be denied or to be regretted; it is not only inevitable but desirable, if he is ever to use the valuable tools of algebra economically. If the process does become automatic after the first few performances, who will be found to assert that the mere repetition of this habituated response will train the pupil to reason?

Let us now examine the case for the verbal problem. Does it offer superior opportunity for developing the ability to think logically? Now, by the verbal problem I do not mean merely the problems of which we now find several sets at intervals through the typical textbook. I mean any verbally stated situation which gives conditions capable of being expressed in mathematical symbols. This means that the pupil must be able to get the meaning presented in verbal form, grasp the relationships involved, translate these into algebraic symbols, and then express the comparison by means of a table, a graph, or, more frequently, by means of the equation.

The analogy between this process of dealing with a problem

involving quantitative relationships and that of dealing with any new situation in life is striking. In both cases the problem is presented concretely, the relationships must be analyzed and compared, possible modes of attack must be reviewed, a choice made and followed to a conclusion, and even then the final result rejected if not consonant with the conditions offered in the beginning. You need only to take some specific case and to examine it carefully to note the exact correspondence of steps. For example, read the account of George Puryear's escape from a German prison camp, which is given in the current number of the *Atlantic Monthly*. Here you have in condensed form a series of problems with an analysis of the steps in their solution. As one of the best examples notice the account of his choice of the exact spot for crossing the Rhine. Here we find the same analysis of factors, determination of relationships between those factors, and a careful balancing of advantage against disadvantage, which is essentially the same as the usual procedure in balancing the quantities in constructing an equation.

The abundance and variety of the material offered for the construction of many new situations, as well as the fact that extraneous factors can easily be eliminated, make mathematics one of the best fields for the development of the power to handle circumstances which are novel. No one asserts that the training which we give in handling quantitative situations is carried over as a whole to other situations. but the initiative in meeting the unaccustomed, the training in methods of attack, the confidence in one's ability to find a solution, and, finally, the critical attitude toward the solution—these valuable results, we are told by many able psychologists, may be carried over to other fields.

In addition to offering the best material for training in logical thinking, the verbal problem gives an opportunity for drill in using the formal processes in unclassified form, and especially offers a vast amount of practice in the manipulation of the most important tool of algebra, the equation. For by maintaining that the aim of developing the ability to reason is more important than the aim of developing skill in the manipulation of the formal processes, I certainly do not mean that the latter should be taught less thoroughly, but only that fewer and less involved processes should be studied. The importance of the verbal problem as a means of introducing the idea of change or functionality cannot be overestimated. This idea of relation-

ship or dependence, which is so valuable, has never been sufficiently stressed and never can be without an abundance of verbally stated material. Add to this the fact that the verbal problem can be made the source of much interest, and the second phase of our discussion is brought up.

If the greater amount of emphasis is to be given to the verbal problem by the writers of textbooks, how can we use this material to the best advantage? I venture to assert that no other phase of algebra is as inadequately presented to the pupil as that of how to solve the verbal problem. From the very nature of the case we do not wish to do the pupil's thinking. We defeat our primary aim in teaching the verbal problem if we do that. On the other hand, we defeat that aim if we give him no clue to the method of attack, for in that case the pupil is apt to do nothing for he does not know how to begin. Here is an opportunity for the teacher to use the wisest discrimination.

In the first place, our difficulties with the verbal problem at present are largely due to the fact that the verbal method of presenting problems is neither used early enough nor constantly enough. This method can be used even in developing skill in the formal processes. Instead of always writing addition problems in symbols, $2a+3a=?$, let us sometimes ask, "What is the sum of $2a$ and $3a$?" Thus, early in the course, accustoming the pupil to the translation from words to algebraic symbols. We have been demanding that he translate a whole paragraph without knowing any vocabulary. At this early stage, inverse translation or translating algebraic symbols into words should be introduced. Our present method could be compared with that of teaching an elementary course in Latin by making every day a "prose day" with no practice in translation into English. I have found no aid in teaching verbal problems more effectual than this practice in translating algebraic symbols into verbal statements. By easy stages a class can be led to ability to translate a quite involved equation into a verbal problem for which the given equation is valid. A great deal of interest can be aroused by having various pupils read their problems aloud, the others trying to find any discrepancy between the algebraic and the verbal statement. Thus the symbols come to have a meaning for the child as symbols, and he also learns to compare critically the equation and the problem.

Practice in constructing equations in semi-verbal form is of

great assistance in the beginning. One of the simplest cases is that of a greater number, a lesser number, and their difference. Ask the pupil to balance these quantities in every way possible, using those words and the signs +, −, = as he needs them. Some pupils will be able to arrange the quantities in only one way and others can do it in three ways. After a discussion of this with more involved situations the class will grasp one of the most essential ideas in the construction of equations from verbal material.

I have found one of the greatest aids in overcoming the tendency of the pupil to be appalled by the mere reading of a verbal problem, so that he will not even try to solve it, to be that of dealing with the problems by types. There is no denying that verbal problems can be divided into types, a special mode of attack often being applicable to a type. Probably the problems most easily so classified are those the parts of which are related according to some simple formula, as for example, time rate and distance problems, area problems, and various others may be grouped according to this method. If the use and manipulation of the simple formula has been properly taught early in the course, the pupil has no difficulty in expressing the relationship of its component parts. This is even more facilitated by the use of tabular devices. My pupils have responded readily to the suggestion of writing the formula first and then arranging in columns each item in the formula with its corresponding value in the particular problem under discussion.

This way of presenting the verbal problem accomplishes an important function for the slower pupil. While the bright boy or girl will at once grasp and remember any tabular devices or schemes which you may offer as an assistance to orderly thinking, the slower pupil must have practice in using these devices before they become a part of his mental equipment, to be called upon when needed. These tabular devices and the association of certain forms with certain kinds of problems may remove some of the problem-solving value, but that is more than offset by the fact that the child feels more confidence in attacking the problem and so is encouraged to go ahead and do the thinking which under other conditions he would not even attempt.

In connection with the consideration of aids in getting the pupil started, which is by far the most difficult feat the teacher has to accomplish, I beg to differ with those who tell the pupil

to let x represent the smaller of the unknown numbers. He can readily be made to see that it is not always most convenient to represent the smallest number by x, but rather, that number in terms of which the other unknown quantities are expressed. By giving him a few examples where the use of x for the smallest number is decidedly inconvenient, he will soon grasp the point and use that principle thereafter. This appears to me to be one of the best opportunities for him to see relationships and to express them economically.

Finally, to develop those methods of thinking which will be most valuable to him later, we must painstakingly train him to check his work and to realize that a problem is not solved until he is sure that the solution is correct. A little judicious ridicule of absurd answers will assist in fixing the idea of the importance of this step. A pupil who brings an utterly absurd answer for a problem, and is satisfied with it, has yet to develop that critical attitude towards results which is perhaps most effectual in separating the successful from the unsuccessful in any undertaking.

I have, hastily, and I fear very inadequately, outlined the arguments advanced by those who are actually engaged in reversing the emphasis in ninth-grade mathematics. If you are convinced that our primary aim is to train thinkers and that the verbal problem offers the best material for use in that training, then, certainly, you will admit that we should be concerned about our methods of presenting that phase of the work.

REPORT OF THE GEOLOGICAL SURVEY ON THE NENANA COAL FIELD, ALASKA.

The Nenana coal field, which lies about two hundred miles north of Cook Inlet, Alaska, and will be reached by the new Government railroad from Seward, 364 miles distant, has been examined by G. C. Martin, of the United States Geological Survey, Department of the Interior, whose report on it has just been published. The field is about one hundred miles south of Fairbanks, the inland terminus of the railroad, and is more accessible to the gold mines of the Tanana Valley than any other coal field in Alaska.

The coal is a lignite of good grade, which, when the field is made accessible, will be used as locomotive fuel on the railroad, for generating power and for thawing at the gold mines, as domestic fuel in the region, and as fuel on steamboats that ply on Tanana River and possibly on some of the boats on the Yukon.

The report gives the classification of the coal land and non-coal land in the field by sections, contains detailed maps showing the areas of coal-bearing and non-coal-bearing rocks, and gives detailed statements of the conditions of mining and transportation.

A SHORT LABORATORY COURSE IN RADIOACTIVITY.

By James L. Clifford,

Evansville, Ind.

It is the purpose of this brief article to give a few experiments in radioactivity which may be incorporated in any physics or chemistry course. In the past the teachers of chemistry and physics have confined their discussion of radioactivity to the explanation of that given in the textbook. In order to impress the wonder of this new phase of science upon the mind of the student, experiments should be conducted illustrating the properties of radioactive substances. Contrary to the general belief, it is not difficult or expensive to perform several instructive experiments along this line. This short discussion is divided into three parts, each part describing an experiment illustrating one property of the radiations from active substances. It would be best to perform these experiments in the order in which they are given. It is not the purpose of this article to explain radioactivity or to give the history of this fascinating study. For this, the reader is referred to any standard treatise on radium or radioactivity.

Before entering upon the discussion of the experiments, the necessary apparatus and chemical compounds will be given. In the first place, a spinthariscope should be purchased. One of these instruments can be purchased at any prominent supply house, at the expenditure of only a few dollars. Several salts of uranium and thorium should be secured; the author has used uranium nitrate, uranium oxide, uranyl chloride, thorium nitrate, etc. About ten grams of any one of these salts would be sufficient for simple experiments. The other materials used are not unusual, and will be found in any well equipped laboratory. For a more complete discussion of this subject the reader is referred to the issues of *Everyday Engineering Magazine*, from November to February of 1918 and 1919.

Photographic Effect.

In 1896 Professor Henri Becquerel of Paris made the discovery that the salts of uranium would affect a photographic plate even through substances opaque to ordinary light. This action was later shown to be caused by rays which were given off by the uranium salt. These rays are of three kinds, called the alpha, the beta, and the gamma rays. It was shown that the photographic effect should be attributed to the penetrating beta rays, which are in reality electrons. They were found to

travel at enormous velocities, even approaching that of light, and could penetrate thin sheets of metal.

In order to illustrate this photographic effect of the beta rays, in the class room an ordinary camera plate and holder is used. The plate is used in the holder just as it is arranged for regular photography, as is shown in Figure 1. A small heap of some active salt such as a uranium or thorium compound is now placed upon the thin wood shield which keeps the plate from the light. To increase the effect a thin cardboard sheet may be substituted for the wood. This would allow more of the radiations from the salt to pass and thus would make the impression stronger.

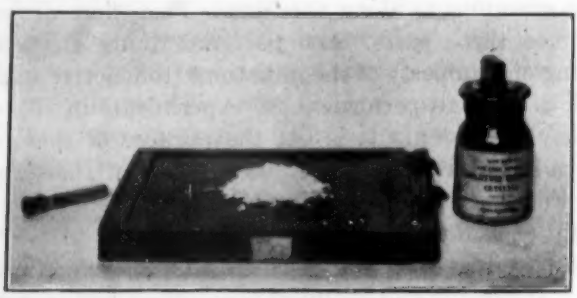


Fig. 1

When metal objects such as keys, buttons, pens, etc., are placed under the radioactive salt a silhouette of the object is formed. The beta rays are retarded by the metal and for this reason the interposition of any metal object is shown in the photograph. The retardation of metals for the rays is not uniform, varying with the density, so lead cuts off more of the rays than does aluminum.

The time of exposure is not always the same, depending mostly on the activity of the substance. For most practical purposes an exposure of three days is sufficient for any uranium or thorium salt. Using a few milligrams of radium bromide of activity 40X a clear exposure may be obtained in about two days. In any case, the exposure necessary for clearness can only be determined by experimentation. In Figure 2 is shown a photograph of a key taken through a black cardboard screen using an active compound. The salt, spread over the key, completely covered the portion of the plate here shown. In this case the plate was completely exposed under the salt, except where the key cut off the rays.

In carrying on experiments of this nature in the laboratory, it is sometimes better to use the active portion of the spinthariscope instead of uranium or thorium salts to affect the photographic plate. The activity of this is so much greater than the salts obtainable, that much clearer and quicker pictures can be obtained using it. As will be explained later the active portion of some spinthariscopes is at the end of a small needle, while in others the active salt is placed directly upon the zinc sulphide screen. In the first case the needle should be removed, and the active end placed over the key or object to be photographed. In the second case the lens should be removed and the portion holding the screen inverted over the object to be photographed. Very good pictures, or radium-graphs as they might be called, can be obtained using the spinthariscope.

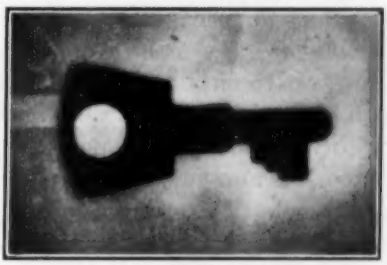


Fig. 2

For use in the class room the following suggestion might be made in regard to this experiment. Of course the photographs might be made beforehand by the instructor, and then shown to the students, but greater interest is aroused if both the beginning and the end of the experiment is seen. Since this takes several days to perform, some other experiment should be interposed between the arranging of the apparatus and the viewing of the result. The author would suggest the use of the following.

Ionizing Effect.

As has been previously stated, radioactive substances give off alpha, beta, and gamma rays. All of these radiations possess the property of forming gaseous ions in the gas through which they traverse; but practically all of the ionization caused by active salts can be attributed to the alpha rays. These rays are in reality helium atoms which travel at an immense velocity. It is by this ionizing property that radioactive substances are chiefly measured. A charged body placed in an ionized gas loses its charge proportionately to the ionization of the gas, or

to the activity of the agent producing the ionization. Thus we have a way of measuring either the ion producing power of the rays from radium, or the strength of the activity of the substance which emits them.

For detecting this ionization caused by the radiations from active substances a gold leaf electroscope is utilized. The ordinary flask electroscope is unsuitable for this kind of work, so another type should be constructed. The design of the electroscope found most suitable by the author is shown clearly in Figure 3. The container is made from ½ inch oak or mahogany which can be procured at any planing mill. It would be out of place in this article to describe minutely the construction of this electroscope as the illustration is self-explanatory. The gold leaf system, however, should receive some attention.

A brass strip ¼ inch in width and about six inches long is well smoothed to obviate any leakage in the charge. This is soldered at the lower extremity to a round brass disc also well smoothed and polished. The strip is now inserted in a hollow cork, being sure to see that it does not touch at any point. The inside of the cork is now filled with melted sulphur, which is then allowed to cool. This insulates the brass strip well from the cork as sulphur is one of the best insulators known. The cork is now placed in position in the hole in the partition. The gold leaf is attached to this strip by means of a tiny drop of adhesive, about an inch from the upper end. The gold leaf is viewed through an ordinary reading glass having at least a five inch focus. A hole is cut in the back of the case directly behind the reading glass. Across this a piece of white paper is glued upon which a scale is drawn in black ink. When a light is placed behind this piece of paper it illuminates the chamber and permits accurate observations of the fall of the gold leaf to be made.

Some device for varying the distance between the active preparation and the brass disc should be provided. The manner depicted in Figure 3 is both simple and efficient. A slot is cut out of one side of the lower chamber and a round brass rod is run through the center of this. An adjustable slider fits on this, having an arm extending into the ionization chamber. The active salt is placed upon this arm. A scale is arranged upon the side of the case, to allow the exact distance of the arm from the disc to be noted.

The instrument may be used as follows: A charged hard

rubber rod is brought into contact with the round brass disc, and the gold leaf brought into the desired position on the scale. The time required for the gold leaf to pass over a set number of divisions due to the natural leak is now noted. The number of divisions per minute is the natural leak of the electroscope,

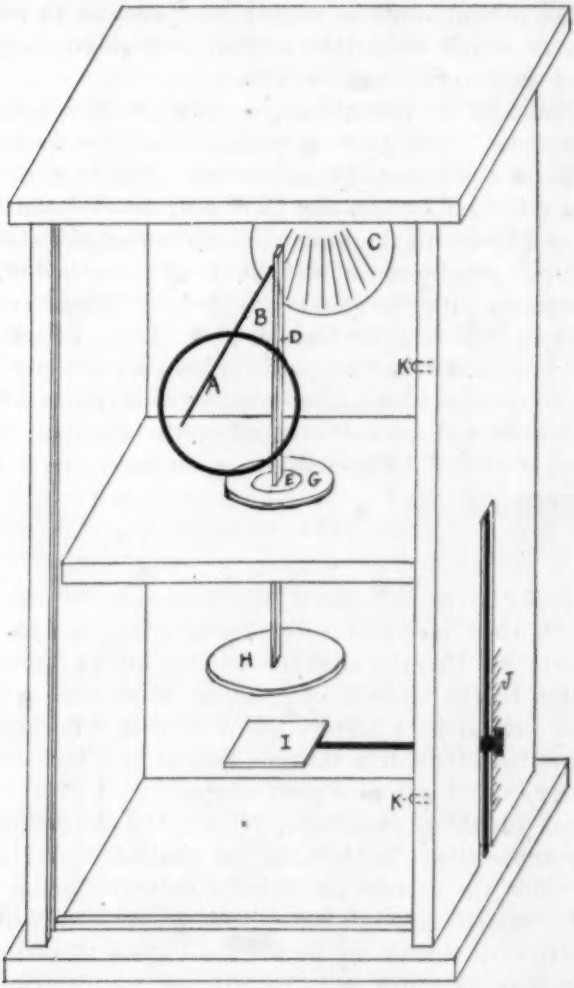


Fig. 3.

and is called t. An active material is now introduced into the electroscope and the time required for the gold leaf to pass over a set number of divisions is again noted. The average number of scale divisions passed over by the leaf in one minute is called t_1. The activity of the material is proportional, then, to $t_1 - t$.

In measuring the activity of any substance a standard must be had. A good method to use in obtaining a standard is that first employed by McCoy. Some uranium oxide, black (UO_2) is dissolved in either ether or chloroform, after having been well pulverized. This solution is now spread evenly over a weighed metal disc of aluminum or copper, and allowed to evaporate. This leaves a uniformly thin surface of uranium oxide. The weight of the film can easily be determined.

Practically all the ionization caused by this film is due to the alpha particles. One gram of uranium has been found to give off 2.37×10^4 alpha particles per second. The number of alpha particles given off by the film can easily be deduced by these figures, and from this the number of alpha particles given off by the unknown substance can be figured. The method of comparing a substance with this standard is given as follows: t equals the natural leak, and t_1 is the number of divisions per minute that the gold leaf passed over when the unknown substance is placed in the electroscope, and t_2 is the number of divisions per minute that the gold leaf passed over when the standard is in the ionization chamber. The activity of the unknown is given by the ration:

$$\frac{t_1 - t}{t_2 - t}$$

The radioactivity of several substances can be measured by comparing their respective discharging currents. In the case of uranium and thorium salts the activity will be found to be in proportion to the amount of uranium or thorium which each contains. If accurate results are desired a stopwatch should be used to time the fall of the gold leaf, but for class room work an ordinary watch will give good results.

Several of these electroscopes may be constructed very cheaply and easily. In this case the students could be allowed to determine the various activities of several samples of radioactive compounds, as a laboratory experiment. Very interesting and instructive results can be obtained using this simple piece of apparatus. It may also be utilized for determining the ionization caused by other agencies than radioactive substances. It is a useful instrument for any laboratory.

Phosphorescent Effect.

The alpha particles emitted by radioactive substances cause a marked phosphorescence in certain materials such as platinocyanide of barium, diamond, and zinc sulphide crystals. This

property is utilized in the making of luminous paint for watches and dials. These paints are simply mixtures of crystalline zinc sulphide and some salt of radium or, in some cases meso-thorium. The active salt gives off alpha particles which cause the zinc sulphide to give off a pale green light. This property is also utilized in the construction of the spinthariscope. This instrument, as designed by Sir W. Crookes, clearly shows the phosphorescence produced in zinc sulphide by the rays from radium. The construction of the usual form is shown in Figure 4. At one end is a screen of phosphorescent zinc sulphide, which is watched by means of a small adjustable lens. About a quarter of an inch away from the screen is placed a small needle on the end of which there is a minute speck of some radium salt. This bit of radium gives off a great number of alpha rays which are in reality helium nuclei. They strike the zinc sulphide screen and cause it to fluoresce. In some spinthariscopes the active salt is placed directly upon the screen, thus giving more phosphorescence for a smaller amount of salt. Using the needle to hold the active salt is by far the better way, however.

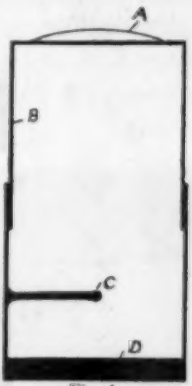


Fig. 4.

Upon viewing the screen through the lens, it is seen to scintillate in a number of distinct dots. Each bright dot is caused by the impact of a single alpha particle. Of course the observer must use the spinthariscope in a dark room in order to see the scintillations. The room should be darkened several minutes before observations are made in order to allow the eyes to become accustomed to the dark. The never-ending wonder of radium is impressed upon the student more by watching the glow of dancing lights in the spinthariscope than by any other experiment. It would be well to impress upon the student that what he sees is not radium itself but simply the effect of radium. Some people are apt to think that the scintillations in the spinthariscope is radium itself. This is only a proof of the activity of radium as the activity can never be seen itself. Another wonder to the lay mind is the length of activity. He sees the ceaseless activity, and can scarcely believe the fact that this activity will probably endure for centuries, without any measurable decrease. And to think, too, that all this activity comes from a speck of matter nearly too small to see with the naked eye.

A CHEMICAL MUSEUM FOR HIGH SCHOOLS.

By Oscar R. Foster,
Manual Training High School, New York City.

There are a number of devices in daily use by chemistry teachers to stimulate interest of secondary school pupils in chemical science. One excellent way which I have successfully employed for encouraging students in this study is the frequent use of hand specimens from a chemical museum. Also I have found this to be an illustrative aid when advising properly qualified students to pursue chemistry as a life work in higher institutions.

Fig. 1.

The idea of a chemical museum in a high school is not new; however, not all secondary schools are so equipped. The method which I have employed to establish a museum is to place in it exhibits which can be used for both reference and class room work. Specimens are securely and cheaply mounted so as to minimize breakage and also give a unit of convenient size for hand to hand inspection. The mountings are inexpensive and usually are made from material on hand. Although

exhibits which are placed in the museum from time to time illustrate the more important matters in the text, never-the-less related matters are also represented. Manufactured products are especially sought and those from local factories emphasized. This is designed to attract the attention of the pupil to the usefulness of chemical products in everyday life.

When the museum here illustrated was started, it was considered wise to use glass cases located in the hall so that students would see the material constantly. I have noticed frequently that, before and after school as well as during lunch period, groups of boys will pause to examine the specimens and discuss them. The excitation of natural curiosity and spontaneous consideration of these matters increase the effectiveness of chemistry teaching.

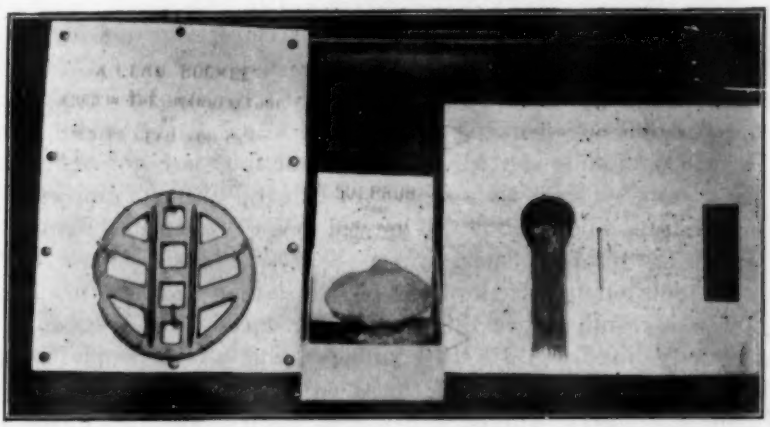


Fig. 2.

The objects are generally mounted on heavy white cardboard of convenient size, 8 inches by 10½ inches; they are firmly attached by cotton covered wire; heavy objects are mounted on several thicknesses of cardboard and these are held together by paper fasteners. Bold plain lettering is employed for labeling and to call attention to some salient fact in connection with the exhibit. The mounted specimens may be carried to the class room. Another method for employing them is to send a boy with pencil and paper to the museum case during a recitation, with instructions to bring back a brief description of one of the exhibits. These notes he may transcribe to the blackboard or read them to the class.

Fig. 1 gives a view of one compartment of the museum. The

photograph shows some of the cardboard mounts above described. Fig. 2 is a nearer view of three of the exhibits showing the bold lettering and brief description.

Such a collection of manufactured products serves to bring the student into closer touch with many objects about which he must learn, but which are not illustrated in his text book. The added interest shown by pupils when this method of illustration is employed is ample repayment for the time and labor spent in the collection and preparation of this material. I believe such a museum to be a valuable adjunct to instruction in chemistry.

THE AGRICULTURAL SHORT COURSE IN THE HIGH SCHOOL.

By C. K. McWilliams,

High School, Geneseo, Ill.

The boy in the public schools who is being educated for the farm must know more than railroad specials or Farmers' Institutes can give him and the schools must be capable of giving these underlying principles. He must know something of the chemistry of soils and why certain plant food is required for a given crop. This is the scientific or cultural phase of education for the farm, and the boy will do well to get this cultural foundation in the public schools.

In 1860 but one-sixth of the people resided in towns of over 800 inhabitants and in 1890 practically one-third of the people were city dwellers. In 1910, 45.3 per cent of the people lived in cities of 2,500 or more. As the rural population decreases more machinery will be introduced to perform the farming operations. This will demand a greater investment of capital, and the greater the investment, the more brains and training needed to direct it along the line of profitable production.

Prof. C. J. Galpin, in Wisconsin Bulletin 288, expresses himself as follows: "The rising value of headwork on American farms opens up a new market for the wares of the high school. The hand farmer, the man with the hoe, is being gradually replaced by the machine farmer; and the great muscles of the hand worker are slowly getting smaller while the higher brain centers of the farm engineer are coming into use. High schools that first perceive this change and adapt their methods to the new country community will first enter into the benefits of this opening intellectual market. Machine thinking is bound to follow machine farming, and a certain type of artless simplicity,

associated from the earliest time with farm life, will begin to disappear."

There are in the United States nearly three million transient farm laborers and perhaps an additional million young men who are just starting life on the farm. They are all practically beyond the reach of agricultural education in the public schools, except those who may be reached through winter short courses. They are busy during the working season but are free to idle their time during the dull season or go to school if opportunity is offered them. It is to these that the Short Course makes its appeal and it is these whom it seeks to train and educate.

In the organization of short courses Minnesota and Wisconsin have taken the lead. Minnesota has for some time made the holding of such a course in Agriculture a part of the requirement for state aid. Wisconsin provides that high schools may establish winter courses beginning between October 30 and November 10. State aid is offered to the extent of two-thirds the salaries of additional teachers required. This is limited in that only fifteen high schools in the state receive such aid and that the amount shall not exceed $500 per school. The course of study must be approved by the State Superintendent of Public Instruction.

Oregon is this year trying out a rather unique form of organization which practically takes care of the pupil who is able to attend only a part of the time. Each year's work in Agriculture is divided into four units and the two units of each semester are alternated every year. This arrangement makes it possible for the boys to attend only during the winter months and yet be able to take all the work offered in Agriculture.

In Illinois a few schools have held short courses but there has been little uniformity as to length of term or manner of organization. Some of these were based on the idea of an extended Farmer's Institute, and continued for a period of from one to six weeks. Those near the State Agricultural College were able to secure strong speakers and did much good work. The main objection to this plan is that the speakers, being specialists in their respective departments are likely to make their lectures too scientific or advanced for the average farm boy. Another fault is that the students are too apt to get a vague idea of the whole field of Agriculture and not enough about any one phase to form a good working basis. Neither do they get any of the closely related subjects such as English, Civics, Farm Account-

ing, etc., which seem to be requisites of the successful farmer of today.

The Short Course offered each winter at the Geneseo Township High School has been in successful operation for six years and is outlined as follows:

Soils and Crops	Animal Husbandry
Horticulture	Farm Arithmetic
General Science	Community Civics
English	English
Farm Mechanics	Farm Management
Farm Carpentry	Business Methods
General Science	Farm Accounting
English	English

The courses are not numbered but are designated according to the agricultural content of that particular year. Since there is no sequence of subjects, a boy may enter any year and derive as much from the course as if he had been in attendance during previous years. The full four years' work must be completed, however, before he is awarded the Short Course Diploma.

General Science occurs in two courses but there is no repetition of subject matter. In the Soils and Crops year such topics as plants, soils, animals, weather, and elementary chemistry are taken up. Simple machines, light, sound, energy, and electricity are studied in the Farm Mechanics year. Perhaps it need not be said that these topics are all emphasized from the farm and home point of view.

In the English work one good classic is studied each year. Constant drills are given in corrective English and much stress is put on oral work, as farmers do not carry on a great amount of correspondence. The boys are encouraged to read the best farm journals and newspapers by having several of these on the reading table. Spelling forms a not insignificant part of the instruction in English and the words are taken from selected lists of practical words, words found misspelled in the pupil's written work, and those gleaned from agricultural texts. Debates on disputed questions in agriculture not only improve the pupil's ability to speak and use good language but also aid him in acquiring a broader knowledge of Agriculture.

Every farmer keeps accounts of some kind, but too often they are jotted down on a piece of board or scratched on a barn door. The boy in the Short Course is taught how to keep

accurate accounts and to figure profits and losses. Many State Experiment Stations issue account books which may serve as the basis for this instruction.

A text in General Agriculture is not to be recommended for use in the short course. Books dealing with the specific subjects are preferable, and while the whole book may not be completed during the term, it serves as a valuable reference after the boy leaves school.

Some good texts that may be used in this work are:

Mosier—Soils and Crops.
Hunt and Burkett—Soils and Crops.
Harris and Stewart—Principles of Agronomy.
Plumb—Beginnings in Animal Husbandry.
Green—Popular Fruit Growing.
Davidson—Agricultural Engineering.
Boss—Farm Management.
Roehl—Agricultural Woodworking.
Brace and Mayne—Farm Shop Work.
Hessler—First Year of Science.
Barber—General Science.
Ward—Sentence and Theme.

Since the Agriculture in the Geneseo Township High School is operated under the Smith-Hughes law, the boys of the short course, as well as those of the regular course in Agriculture, carry out a project during the summer months.

One of the problems that each school will have to solve is the length of the course and when to begin it. No general rule can be given that will apply to all communities equally well. The course must be arranged so that it will come at a time when the boy can best be spared from the farm. In general it should begin after the corn-husking season and may continue until the busy season of spring plowing begins.

The Wisconsin plan of half a year's work given in the winter for the farmer boys is an excellent one and fits into the administration scheme nicely, but in most corn-belt states a course of that length would extend into the busy seasons and defeat its own purpose. The problem is not one of a nice adjustment to the course of study but rather the best accommodation to the boy. A ten week course, beginning immediately after the Christmas vacation, is one of the best solutions to the problem, for it may then run the full time without interference from the holidays or other detracting events.

The entrance requirements for this short term or dull season class should not be so rigid as for regular high school work. Any boy qualified to enter high school classes or who, in the opinion of the principal, is able to master the course ought to

be allowed to enroll. It certainly would not be the desire of a school to hinder any boy who is anxious and capable of doing the work.

At the completion of the full four years of the short course, the pupil may be given a Short Course Diploma certifying the fact. If opportunity occurs at any time during the course the boy should be allowed to enter the regular high school classes on the recommendation of the principal and his standing be based on the quality of work he is capable of doing.

The problem of providing teachers for the short course may be solved by giving extra work to teachers already employed, or by employing a special teacher for this work. There are both advantages and objections to either method, but on the whole, if the regular teaching staff is not already burdened with classes, the first method offers the most happy solution as it means only one extra class per day for each of three or four teachers during the ten-week period. They are likely to remain with the high school for some time and will have a clearer idea of the objects and ideals of the course. The main objections to the special teacher are that he would have too great a variety of subjects to do justice to them all and most likely the same person would not be available from year to year. In case a special teacher is secured, he must be one who understands farm boys; he must know Agriculture and the problem he has to deal with; he must have the vision of a larger and better farm life.

The existing conditions are not fair to the boy nor to the school. These boys are worthwhile fellows who are needed in the schools, while they, on the other hand, are generally anxious to attend and need the training. They cannot do this under the present semester arrangement of studies. It is an important function of the school to see that this class of boys is provided for.

REPORTS ON SOME MINERAL DEPOSITS IN THE UNITED STATES.

The United States Geological Survey, Department of the Interior, has recently published, as Bulletin 690, its annual volume entitled *Contributions to Economic Geology (short papers and preliminary reports), 1918, Part I, Metals and Nonmetals Except Fuels.* This bulletin contains six papers, which deal with zinc and copper ores at Ophir, Utah; gravel deposits in Arkansas, with special reference to their possible utilization as a source of hard pebbles for grinding mills; phosphate deposits in the Uinta Mountains, Utah; quicksilver deposits in the Phoenix Mountains, Ariz.; and manganese deposits near Butte and in Madison County, Mont.

A DEMONSTRATION OF THE COEFFICIENT OF CORRELATION, FOR ELEMENTARY STUDENTS OF PLANT BREEDING.

By HERBERT F. ROBERTS,
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It is often profitable, in teaching the subject of genetics to elementary students, to make tolerably free use of biometric methods, especially in the earlier stages of the course. The writer has found, in his own experience at least, that the careful marshalling and rigorous analysis of data required in the calculation of the chief constants, is of value in training students in precise and accurate methods of work.

It is the purpose of the present paper to discuss a method of presenting the coefficient of correlation. Although this coefficient is little used in inheritance studies today, it nevertheless has a distinct and practical value in demonstrating the general trend of evolution within a group. It deals, of course, only with large numbers and general tendencies, and takes no account necessarily of the genetic conditions existing in any particular case. Within a genetically related population, however, it is able to forecast the incidence of group evolution with respect to the characters in question. It shows, on the average, in a related population, the extent or degree of interdependence of any two given phenotypic (i. e., visible somatic) characters. However, for purposes of breeding, which takes account, not of populations, but of genotypes, the coefficient, as ordinarily found, may have no essential meaning.

Where a high coefficient exists between two correlatives, there must, of course, be a physiological reason involving their common presence in the organism, although the actual proof of the genetic linkage of factors, remains to be determined by the usual process of factorial analysis of genotypes. Nevertheless it is true, that for work in plant improvement to be carried on by farmers, the knowledge of the existence of a high percentage of correlation between two somatic characters may be of substantial practical benefit in commencing the practice of selection. Even though the coefficient is merely of a statistical nature, and has no necessarily direct relation to inheritance, it nevertheless may frequently point the way to the existence of a possible linkage of characters, determinable through genetic analysis.

Pearl (3, p. 15), sums the matter up satisfactorily in the statement:

> Heredity is not the sole cause which can lead statistically to a significant correlation between parent and offspring. (p. 69.) The coefficient merely indicates the existence of association, but does not state for us upon what basis that association rests. . . . It may be inheritance. . . . it may be local environmental differences, or it may be anything whatever, so far as the correlation method *per se* helps us.

However, the determination of the existence of such association, in the case of somatic characters, in genetically related individuals, may serve as a reconnaissance basis for actual selection of genotypes for breeding purposes.

Quoting Pearl again (p. 70):

> There can, of course be no valid objection to the study, in and for itself, of the correlation existing between genetically related individuals in respect of somatic characters. Such studies may, indeed, for one reason or another, have a high intrinsic interest . . . but, in dealing with such correlatives, one should always keep closely in mind that he is not dealing directly and primarily with phenomena of inheritance, but only indirectly and secondarily. . . . The only way to determine whether the "differences" indicated by the correlative method are really heritable is to apply the method of individual pedigree analysis to the complex heterogeneous material of the table. If it is possible to isolate and propagate distinct genotypes from the material, then it may be concluded that the primary basis of differentiation or heterogeneity detected by the correlation coefficient was inheritance.

The coefficient has been recently utilized by Rugg (4, pp. 246, 261), in demonstrating the degree of association, irrespective of causal relationship, existing between such measurable educational data as "ability in mathematics," "ability in languages," "ability in drawing," "ability in shop practice."

For elementary students in genetics, at any rate, a certain amount of work in determining the correlation coefficient, provided its meaning and range of application are made clear, is of value for training in the orderly and systematic arrangement and classification of data, indispensable to future work in breeding.

The graphic method of illustrating the association of variable biological factors supposedly interdependent was first used by Francis Galton in his studies of inheritance of human stature. It seems, however, according to Rugg (p. 350), that Bravais in 1846, was the first to suggest that the degree of association between two factors could be represented in terms of the sum of the products of the deviations of the variates from their respective means. Bravais, however, did not, it appears, express the degree of this relationship in the form of an equation or a coefficient. Pearson, in 1896, furnished the statement of the equation for the regression curve, and of the coefficient of correlation.

For the purpose of illustrating a method of demonstrating

the nature of the coefficient of correlation to students, which the writer has found satisfactory, a concrete case may be taken, of the correlation between length of ears of corn in inches, and their weight in ounces, as given by Davenport (2, p. 458). For convenience, the table, somewhat modified, is here given

y	X	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
		865	765	665	565	465	365	265	165	065	035	135	235	335	435	535	635	735	835	935	1035	
3.0	4.85	1	2		1																	4
3.5	4.35	·	4		1																	5
4.0	3.85	3	5	5	1																	14
4.5	3.35		6	5	4			1														16
5.0	2.85		2	4	7	2	4															19
5.5	2.35		2	9	15	14	8	4	1													53
6.0	1.85		1	2	12	16	13	13	6	1												64
6.5	1.35			1	6	11	26	11	8	6	1											70
7.0	0.85			1	2	2	12	18	12	12	11	4	1									75
7.5	0.35				1	2	4	20	12	13	21	11	6	6	1	1						98
8.0	0.15						3	7	19	25	17	22	17	3	1							113
8.5	0.65				·		1	1	12	9	23	30	26	26	5	1						134
9.0	1.15				·				1	7	10	23	35	26	24	12	1	2	1			142
9.5	1.65									1	4	14	19	29	17	10	1	3		1	1	100
10.0	2.15									1	1	3	8	18	10	6	4	2				53
10.5	2.65												2	3	6	7	2	5	1			26
11.0	3.15													1	1				2	1		5
11.5	3.65																	1				1
		4	22	27	50	47	71	75	71	75	88	107	114	112	65	37	8	13	4	2	1	993

TABLE I—CORRELATION TABLE BETWEEN LENGTH OF EARS OF CORN IN INCHES (SUBJECT), AND WEIGHT OF GRAIN (RELATIVE), IN OUNCES.

First (left hand) vertical column, length of ears in inches; second vertical column, deviations from the mean. Upper horizontal array, weight of grain in ounces; lower horizontal array, deviations from the mean. Constants of the table: A, $Y = 7.85 \pm 0.03$. A, $X = 10.65 \pm 0.08$, $\sigma\, Y = 1.57 \pm 0.02$; σ. $X = 3.63 \pm 0.05$; $r = 0.87 \pm 0.005$.

The constants are as follows: $\sigma x = 3.63$ oz.; $\sigma y = 1.57$ in. $r = .87$. In order to let the student understand the significance of the correlation table and the coefficient, the means are now found for the vertical and the horizontal columns, and these are plotted as in Figure 1. We have here the means of the horizontal columns (average weight of ears in ounces), corresponding to the units of difference in length of the ears in inches. Plotting the best fitting line for the moments, we have the graph GH, the equation for which is $y = r\ y/x.\ x = 1.88x$. Correspondingly, we have the means of the vertical columns (average lengths of ears in inches), corresponding to the units of difference (ounces) in the weight of the ears. Plotting the

best fitting line for the moments, we have the graph IK, for which the equation is $x = r\, x/y.\, y = 2.01y$. The solution for these equations has sometimes been termed the "regression coefficient."

Following are the data for the moments:

Length of Ears, Inches	Average Wt. of Ears, Ounces	Weight of Ears, Ounces	Average Length of Ears, Inches
4.85	7.40	6.65	4.10
4.35	6.12	7.65	3.57
3.85	7.36	6.65	2.99
3.35	6.52	5.65	2.33
2.85	5.54	4.65	1.81
2.35	5.02	3.65	1.43
1.85	3.99	2.65	1.01
1.35	3.33	1.65	0.69
0.85	2.10	0.65	0.62
0.35	1.80	0.35	0.63
0.15	1.47	1.35	0.80
0.65	1.90	2.35	0.70
1.15	2.87	3.35	1.44
1.65	3.38	4.35	1.53
2.15	3.77	5.35	1.69
2.65	5.25	6.35	2.08
3.15	6.75	7.35	1.90
3.65	7.35	8.35	2.52
		9.35	2.40
		10.35	3.65

The student should have carefully explained to him the difference between the regression lines or graphs, GH (regression of x on y), and IK (regression of y on x), on the one hand, and the graph of the correlation coefficient, EF, on the other. It is well to remind the student that in the three equations,

$y = 1.88x$ (GH),

$x = 2.01y$ (IK),

the coefficients of regression, on the one hand, and

$x = .87y$ (EF),

the coefficient of correlation on the other, are to be held in mind as representing two distinct concepts.

The ratio $x/y = .87$ is taken as the tangent of the angle that the graph EF, of the correlation coefficient, makes with the horizontal. Instead of leaving the student with the simple statement that with perfect correlation, the coefficient is 1.0, and that tan. $\alpha = 1$, when $\alpha = 45$, and that then we have CD as the correlation curve, it is well to develop the idea further, upon the basis of the graphical meaning of the tangent in reference to the coefficient of correlation. The value of the tangent of the angle α at 45° is 1. (Figure 2.) The value of the correlation coefficient is always the value of the tangent of the angle which the correlation line forms with the axis of X, where it

passes through the point of intersection of the axes X and Y. In the figure, CD is the correlation line, where the value of the correlation coefficient is 1; i. e., where the angle COX or α is 45°, and the tangent of that angle is 1. GH is the correlation line, for example, when the coefficient of correlation (r), is .74.

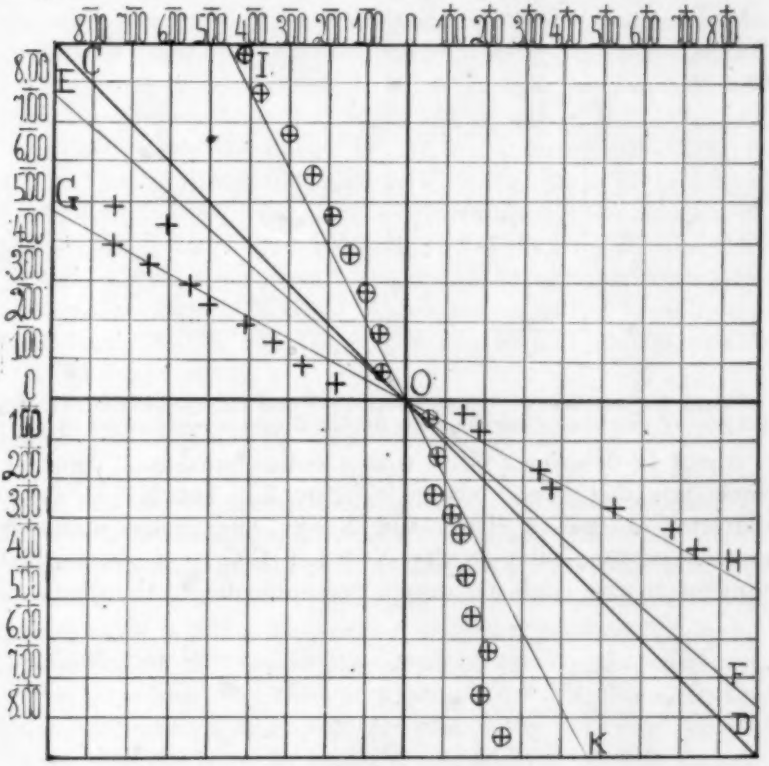

FIGURE 1.
Regression table, showing regression of X on Y (GH), or Y on X (IK) and correlation graph, EF.

Referring to a trigonometric table of natural tangents, we find that .74 is the tangent of the angle 36° 30′. We accordingly take GO to form the angle γ, or GOX, of 36° 30′.

In the case in hand, the correlation coefficient of length to weight of ears of corn, .87, is practically identical with the tangent .8703 of the angle 41° 2′. We accordingly draw the line EF through O (Figure 2), forming the angle EOX, or β, of 41° 2′ with the axis X. This, then, represents the line or graph corresponding to the correlation coefficient, .87.

The relation of the tangent to the correlation coefficient, can, however, be made clearer to students by presenting the

subject from the standpoint of the numerical value of the tangent as a line; i. e., as the line tangent.

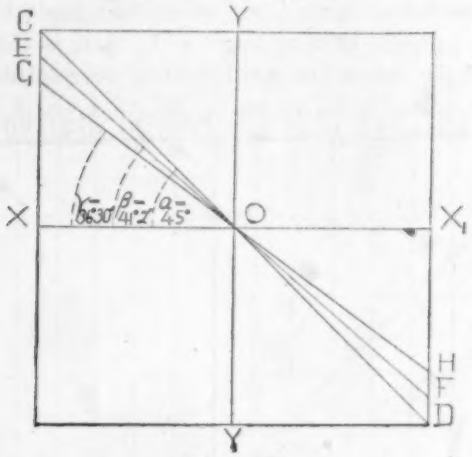

FIGURE 2.
Graph for $r=0.87$ (E F), and supposed case for $r=0.74$ (G H), for purpose of demonstrating the angle for the tangents represented by r.

About O, describe a circle with a radius equal to 1. Such a circle is called a unit circle. (Figure 3.) Let $X-X_1$ be a diameter of such a circle, and $Y-Y_1$ be another diameter erected perpendicular to $X-X_1$. Let CX be a geometrical tangent to the circle O, drawn perpendicular to the diameter

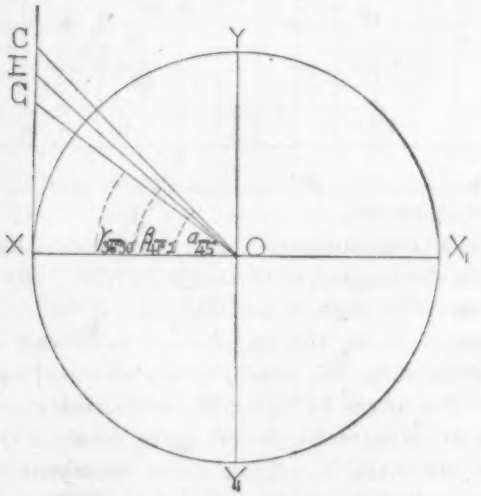

FIGURE 3.
Unit circle, for purpose of demonstrating the numerical or line value of the tangent CX to the angle α (45°), and the value of the tangents for the angles β and γ, where $r=0.87$ (E O), and 0.74 (G O).

$X-X_1$, and CO a line bisecting the angle YOX, and intersecting the tangent CX at C. Then the triangle CXO will be a right-angled triangle, of which the angles COX and OCX, each by construction, equals 45° and the sides CX and OX are equal. But, by construction, the side OX equals 1. The line CX therefore also equals 1, and since the line CX is tangent to the circle at X, then the numerical value of such a tangent, limited by the point of intersection of a line forming an angle of 45° with the horizontal axis OX, is 1.

From O, draw the lines OE and OG, intersecting CX at E and G, and forming the angles 41° 2′ (β), and 36° 30′ (γ), respectively. Now, by simple mensuration, the length of the line CX is found to be 100 mm., and of the lines EX and GX, 87 and 74 mm., respectively. Since CX by construction equals 1, then the values of EX and GX as percentages of 1, are found by taking EX/CX and GX/CX = 87/100 and 74/100, or .87 and .74, respectively.

We thus have the idea of the tangent presented from the geometrical standpoint, and represented as the numerical value of the line tangent in terms of percentages of its limiting value, and this is expressive of the value of the correlation coefficient, in that it states the value of the tangents of the angles which correlation graphs such as EO, GO, etc., form with the horizontal. Since the correlation coefficient is simply the coefficient of y in the equation $x = ay$ the numerical value of the coefficient determines the slope of the correlation curve.

The same idea may then be presented to the student in the usual language of trigonometry with greater facility. Since CX and OX are equal by construction, and the numerical value of the tangent, expressed as a line, being, let us say, EX/CX or 87/100 = .87, it will also be true that EX/OX, or the opposite leg, /adjacent leg, of the triangle COX, = .87 by mensuration. By making the angle COX or α, an angle from 45° to 0° we have the line CX becoming constantly shorter than the line OX, and therefore the value of CX/OX becoming continuously less and less, so that when the angle α becomes as small as 1°, the value of the tangent, which began as 1.0000, has diminished to 0.0003, and finally when $\alpha = 0°$, CX/OX = 0.

By thus treating the tangent from the geometrical standpoint, its value and its relation to the correlation curve are made clearer than by merely referring to it as a trigonometrical function. The graphical exposition and meaning of the coefficient

should be made as clear and definite as possible, where the plotting of the correlation tables forms a part of the laboratory work.

The fact of the correlation coefficient being simply the coefficient of the equation $x = ay$, should be impressed by an example for which the following may serve as a means of demonstration:

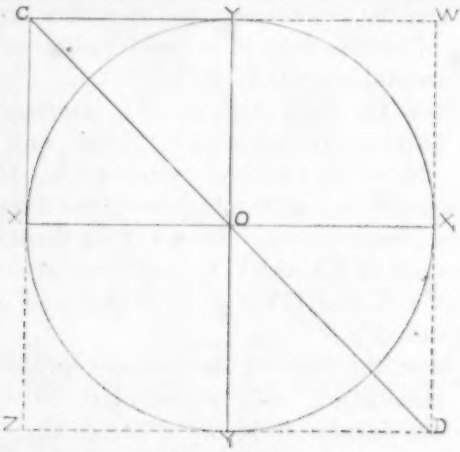

FIGURE 4.
Demonstration of principle of the construction of the regression table upon the basis of the unit circle.

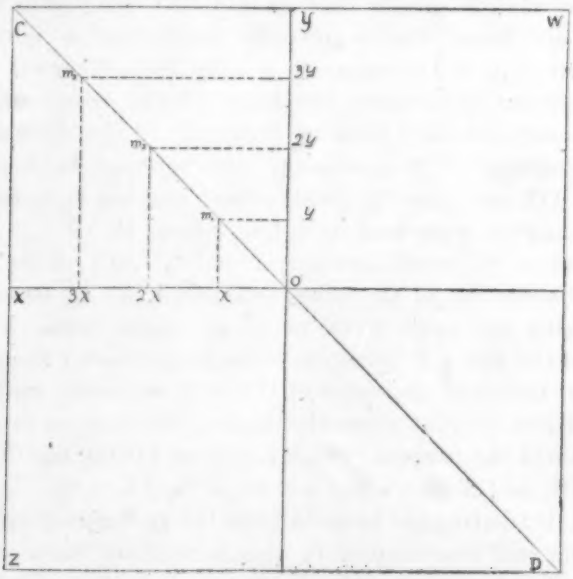

FIGURE 5.
Regression table showing m_1, m_2, and m_3; plotting of moments of curve, when tan. α or $r = 1$, i. e., when $X = Y$.

In the circle O (Figure 4), we may regard the diameters $X-X_1$ and $Y-Y_1$, as a system of coordinate axes, independent of the circle, and which we may call X and Y, respectively. Let us take the axis Y parallel with, and equal to, CX, joining C and Y parallel to XO, likewise completing the rectangle CWDZ, with the line CO projected to intersect WD and ZD at D. The side CX, therefore, of the triangle COX, is by construction, parallel to and equal to the axis Y. Now we have tan. α = CX/OX, or, transposing, CX = OX tan. α. But, substituting axis Y for CX, and axis X for OX, we have $y = x$ tan. α. Applying this equation to the location of points along the line CO, where tan. $\alpha = 1$, we have $y = x$, $2y = 2x$, $3y = 3x$, etc. (Figure 5.)

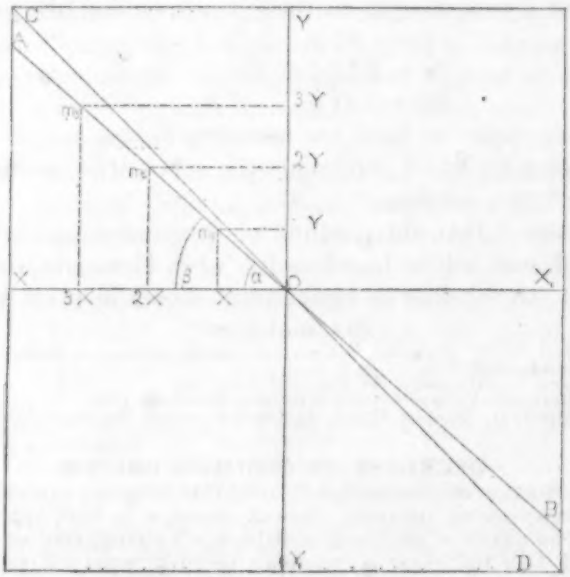

FIGURE 6.
Regression table, showing plotting of moments of curve, m_1, m_2 and m_3 when $x = 0.87\ y$, i. e., when tan. α or $r = 0.87$.

Now, if we plot equal distances on Y and X in any unit whatsoever, and erect perpendicular lines on X from x, $2x$, and $3x$, and on Y from y, $2y$, and $3y$, they will intersect at the points m_1, m_2, and m_3. If we continue to plot units on the axis Y until we reach Y, and on the axis X until we reach X, we find the perpendiculars erected at Y and X intersecting at C. We therefore have the points C . . . . m_3, m_2, m_1, on a line which, by a corresponding course of reasoning, can be shown to intersect the axes Y and X at O. This line C . . . . . m_3, m_2, m_1

. . . . . O, is therefore the curve, or graph, expressing the equation $y = x$ tan. α, where tan. $\alpha = 1$.

But if such a curve can be plotted for the equation, when tan. $\alpha = 1$, it can also be plotted when tan α equals any decimal fraction from 0.9999 down to 0.0000, or, in other words, the value of the tangent. The value of the tangent being a concrete number, it may be expressed in general by a, and the equation $y = ax$, stands as the equation of any straight line intersecting a pair of coordinate axes, X and Y.

In the present case, the ears of corn employed for illustration, where the correlation coefficient is .87, the tangent value of .87 represents an angle of 41° 2′—the line EO in Figure 3. Taking the equation $y = ax$, or $y =$ tan. αx, we have the following values for y with respect to their corresponding abscissas:

$$x = .87\,y$$
$$2x = 1.74\,y$$
$$3x = 2.61\,y$$

Plotting these, we have the moments m_1, m_2, m_3, of the line AB, (Figure 6), which represents the curve of correlation when the correlation coefficient = .87.

It is hoped that this method of demonstrating the correlation coefficient will be found useful, when biometric work forms a part of the schedule in agricultural classes in plant breeding.

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DECREASE IN COMMON BRICK.

The production of common brick, until 1917 the most valuable product of the clay-working industry, showed decrease in both quantity and value. The quantity produced in 1918 was 3,450,612,000, which, when compared with the quantity produced in 1917, 5,864,909,000, shows a decrease of 2,414,297,000, or forty-one per cent. The value of common brick marketed in 1918 was $37,208,000, which, when compared with the value in 1917, $47,936,344, shows a decrease of $10,728,000, or twenty-two per cent. The production in 1918 was the smallest ever recorded by the United States Geological Survey, and the value is the smallest since 1898. Common brick is used principally in the structural industries, which, so far as general operations were concerned, were almost paralyzed in 1918. It is true that the number of Government buildings erected in that year was abnormally large, but the number of brick used in these buildings was comparatively small ,and their use by the Government contributed little to offset the losses in the general demand for common brick. The average price per thousand in 1918 compared with 1917 increased $2.61, or to $10.78, the highest average price reached in recent years in the United States for common brick, and nearly twice as great as it was ten years ago.

INTRODUCTORY COURSES IN BOTANY. I.

By BRADLEY M. DAVIS,
University of Michigan, Ann Arbor.

A committee of the Division of Biology, National Research Council, recently sent to a number of botanists, in the United States and Canada, requests for outlines of what they would plan as the best type of introductory course in botany.

The replies that have been received present viewpoints so different in many respects that it has seemed desirable to publish a number of the outlines in the interest of further discussion and the interchange of opinion. The outlines are to be designated by numbers, and any statements or discussion that may follow will be direct quotation from the author of the outline. By this publication of representative outlines the committee hopes to spread rather widely an understanding of the problems of the introductory course in botany as they appear to different instructors, together with the manner in which some of the problems would be met.

The committee further hopes that this serial publication of the results of their inquiry will lead others to contribute to the discussion and *it will welcome outlines of high school courses in botany* as well as outlines of introductory college courses. Material should be sent to Bradley M. Davis, Botanical Laboratory, University of Michigan, Ann Arbor, Mich.

OUTLINE NO. 1.

A half-year introductory college course, ten hours a week.

1. General morphology of a seed plant followed by details of descriptive organography.
2. Descriptive studies of representatives of important families with field trips to give acquaintance with common trees, weeds, etc. Some plant analysis.

1 and 2 are accompanied by general lectures covering topics of morphology, ecology, foods and food storage, economic botany, forestry, fuels, fibers, drugs, etc.

3. The plant cell; general studies on pith, epidermis, Elodea, with lectures on cell structure and cell contents.
4. Structure and life history of Spirogyra, bread mold, and wheat rust.
5. Structure and life history of a moss. Study of Sphagnum.
6. Structure and life history of a fern.

4, 5, and 6 are with lectures on essentials of morphology establishing the great groups below the seed plants.

7. Seeds and seedlings. Studies on bean, pea, corn, castor bean, pumpkin, onion.
8. Stem structure of corn and Aristolochia.
9. Structure of oak and pine wood.
10. Leaf structure of rubber plant.

7, 8, 9, and 10 have with them lectures on morphology and life history of seed plants, their homologies with pteridophytes, characters of gymnosperms and angiosperms, etc.

11. Cell and nuclear division, root tips of onion. Lectures on protoplasmic structure, reduction of chromosomes, fertilization, alternation of haploid and diploid conditions.
12. Permeability.
13. Absorbing cells, root hairs.
14. Imbibition.
15. Plasmolysis.
16. Transpiration.
17. Conducting tissues.
18. Studies on starch, protein, crystals.
19. Respiration.
20. Digestion of starch, germinating barley.
21. Fermentation of sugar, yeast.

The experiments and studies under 12 to 21 give the basis for lectures and reading on physiological subjects—absorption, photosynthesis, metabolism, storage, cycles of carbon and nitrogen, mineral salts, fertilizers, growth movements, locomotion, irritability, etc.

22. Some general lectures discuss principles of geographic botany, distribution, paleobotany, organic evolution, variation, natural selection, experimental evolution, etc.

OUTLINE NO. 2.

A twelve-weeks course, fifteen hours a week, planned for the Students' Army Training Corps.

1. The leaf. General structure and variety. Microscopic anatomy, variations due to environment. Growth of leaves.
2. Water loss from leaves. Demonstration of water vapor, relative amounts in relation to external conditions as to drought, light, etc. Relation of transpiration to stomata, wilting and recovery.
3. Nutritive processes in leaves. Photosynthesis, conditions, materials, progress, and products. Influence of light. Tests for sugar, starch day and night. Synthesis of protein and fat.
4. Storage of foods made in leaves.
5. Life period of leaves.
6. Importance of leaves as food, etc.
7. The root. Various forms and systems. Microscopic anatomy. Variations of root systems due to environment.
8. Relation of roots to the soil. Physical nature of soils, water and air capacity, etc. Chemical nature of soils, mineral, organic, etc. Fertility. Position of roots and root hairs in soil.
9. Soil requirements of different crops in relation to water, chemical composition, bacterial activity.
10. Diffusion and osmosis. Material income and outgo in root systems, relation to crop rotation, phenolphthalein test. Osmotic pressure and plant distribution, alkali and saline lands.
11. Storage of foods in roots and other underground structures. Economic value.
12. Growth of roots. Effect of tillage. Dry farming practices. Irrigation.
13. The stem. Morphology and anatomy, mono- and di-cots. Growth of stems.
14. Movements of water and food in stems.
15. Wood, structure and kinds of timber. Products from wood, paper pulp, turpentine, etc. Textile fibers, flax, hemp, etc.
16. Pruning, grafting, budding.
17. The flower. Gross anatomy. Biological significance.
18. Sexuality of flowering plants. Process. Relation to breeding and inheritance, production of new forms, Mendel's laws of inheritance.
19. Flower types and their variations.
20. The seed and fruit. Structure and development, biological significance.
21. Common types of fruits and seeds.
22. Food contents of seeds and fruits with tests for starch, sugar, protein, fat, oils.

23. Germination of seeds. Conditions. Behavior. Respiration. Utilization of stored food. Enzymes.
24. Dissemination of fruits and seeds.
25. Seed selection, breeding, contamination.
26. Plant ecology. Habitats and environments.
27. Plant communities. Forest, bushland, grassland, plains, marshes, swamps, and bogs.
28. Origin and development of communities, plant successions.
29. Sanitary relations of plant communities. Relations to game.
30. Principal plant communities of North America and their products.
31. The major groups of plants. Evolutionary principles, Darwin, Wallace, Lamarck, etc.
32. Principal subdivisions of the plant world, with studies on a few types of lower plants.
33. Plant pathology. Organic and inorganic causes of plant diseases. Symptoms of disease. Representative plant diseases. Methods of study. Control or methods of treatment. Economic losses.
34. Some common weeds. Kinds, dissemination, damage, methods of control.
35. Classification of flowering plants. Principles. Significance of structure. Methods.
36. Important economic groups.

"The principal point of view kept in mind in the preparation of this outline and in the plans of the course has been to teach the fundamental facts and phenomena of plant life as related to the everyday life and activities of mankind. The plan was to present the humanely important features of plant science in the light of our modern scientific methods and knowledge."

OUTLINE NO. 3.

A twelve-weeks college course, six hours a week, designed chiefly for students in agriculture.

1. Seeds and seedlings.
2. Roots, absorption, storage.
3. Stems, conduction, storage. Special forms. Buds. Histology of mono- and di-cots. Wood structure.
4. Leaf, photosynthesis. Histology.

1 to 4 with lectures on the work of plants and to contrast the metabolism of plants and animals.

5. Fern. Morphology and life history to establish alternation of generations.
6. Lycopodium and Selaginella. Morphology and life history to illustrate heterospory leading to the seed.
7. Pine. Vegetative structure, cones, gametophytes, and seed formation.
8. Angiosperm flower. Structure and relationship to fructifications of club mosses and gymnosperms.
9. Angiosperm gametophytes, development and significance of the seed.
10. Gymnosperms and angiosperms compared.
11. Algae. Pleurococcus, Spirogyra, Ulothrix, Vaucheria, Fucus. Origin and evolution of sex. Origin of multicellular plant.
12. Fungi. Saprolegnia, Rhizopus, powdery mildews, rust, mushroom. Nutrition of plants lacking chlorophyll. Parasitism. Plant diseases.
13. Bacteria. Morphology, physiology, nitrogen cycle, relation to disease.
14. Yeast. Fermentation.
15. Riccia. Marchantia. Morphology and life history. Origin of the land plant.

16. Moss. Morphology and life history.
17. Comparison of the great groups of plants with development of classification. Seed plants subdivided.
18. Evolutionary principles applied to plants with simple exercises in biometry.
19. Studies on ecological groups with field trips.

"This course is planned on the principles that morphology and physiology cannot be divorced in an introductory course, that a study of structure forms the necessary foundation upon which to build physiological principles, and that structure can be interpreted only in terms of function. Hence I would by no means teach these as separate topics in an elementary course, but by keeping the two constantly in view attempt to interpret the living plant."

"For purposes of laboratory instruction, it seems to me that physiological experiments must for the most part be laboratory demonstrations, on account of the difficulty of providing really profitable physiological work for large classes. Hence morphology must still form the backbone of the laboratory instruction."

(*To be Continued.*)

USES OF ASPHALTIC MATERIALS IN BUILDING OPERATIONS.

The uses of asphaltic materials, including both native asphalt and asphalt made from petroleum, as well as gilsonite, grahamite, and elaterite, in buildings and other structures are manifold. As they are elastic, antiseptic, acid-resistant, and moisture proof, these materials are being widely employed for use in flooring and roofing, in waterproof coating, and in electric insulation, as well as in the manufacture of varnish, paint, and putty. Although these materials have been marketed for relatively few years they are in general demand among contractors and engineers and their use is rapidly increasing.

METAL MINING IN SOUTH DAKOTA AND WYOMING IN 1918 AND 1919.

The Black Hills mining district of South Dakota produced $6,565,209 in gold and 159,246 ounces of silver in 1918. From January 1, 1918, to October 27, 1918, the Homestake mine and mills were operated at full capacity, but during the remainder of the year the property was operated at only seventy-one per cent capacity. This property, which produces the bulk of the output of South Dakota, had not reached full capacity in June, 1919. The Golden Reward, mines and mill, closed in 1918, have not resumed operations. The Trojan and the Mogul mills have both been operated in 1919. The production for the state in 1919 will apparently not equal the production in 1918.

Mines in Wyoming produced 7 ounces of gold, 253 ounces of silver, and 754,324 pounds of copper in 1918. The shipments of silver-copper ore from the Sunrise mine, near Hartville, the principal producing mine in Wyoming for several years, have not been continuous in 1919. A mill has been built to treat the dump ores of the old Ferris-Haggerty mines (long idle) at Encampment. The Rambler copper-platinum mine at Holmes has been idle in 1919.

CLASS WORK IN INDUSTRIAL CHEMISTRY.

By Robert M. Ladd,

Aetna Explosive Company.

Historical. It is my custom to assign to each member of my chemistry classes some subject which he is to look up, and on which he is to hand in a written report. Credit is given on this report as if it were a monthly test. Whenever there is a chemical subject which is occupying the attention of the public, I draw at least part of my topics from that line. Hence last year I posted the following list of titles from which each student was to choose one.

1. Distillation of Coal—How Carried On—For What Purposes. Products Obtained. Illustrate Coal Gas Plant.
2. Coal Tar—How Obtained (refer to 1)—Its Uses—Crude—Method of Refining. Products of First Distillation (illustrate)—Their Uses.
3. Coal Tar Dyes—Their History—Their Uses. The German Monopoly (explain)—Our Lack of Factories (explain). Present Situation—The Future.
4. High Explosives—Their History—Their Action—Their Sources. Our Position in Regard to Raw Materials, in Regard to Factories, in Regard to Supplies on Hand. Time Necessary to Prepare Them. Necessity for Building up This Industry.
5. Coal Tar Derivatives in Medicine—List of Most Important—Their History and Uses. The Present Situation—The Future.
6. The Naval Consulting Board of Inventors. History—What It Is—How Composed—Problem Before It—What It May Accomplish for the Country.
7. The Need of a Great National Laboratory. For Preparation for War—For Preparation for Peace.
8. The Chemist and the Steel Industry.
9. The Chemist and the Soap Industry.
10. The Chemist and the Photographic Industry.
11. Hard Wood Distillation—Its Purpose and By-products. Industry in the U. S. The Relation of the Chemist to This Industry.
12. The Chemist and the Packers.
13. The Electro-Chemical Industries.
14. Chemistry as a Field for a Life Work.
15. The Position of the U. S. in the Field of Chemical Manufactures. How We May Improve This Position.
16. The American Chemical Society. History—Aims—Value to the Chemist—Value to Industry—Value to the Science—Value to the Nation. What Membership in the Society Means.
17. Carbon Dioxide—Its Value in Nature and in Manufacture.
18. Value of Chemical Analysis of Water in Connection with a Sanitary Survey.

Because we did not have the class time for the reading of these papers, I suggested to the class that we organize ourselves into a scientific society and meet once a week. At these meetings the papers of the various members would be read, and, in so far as possible, demonstrated. The class took up the suggestion with enthusiasm and when I suggested that we bring the year to a close with an open meeting at which those demonstrations and papers should be presented they entered into the spirit

of the thing, revised their papers in such a way that the demonstration rather than the theory was emphasized, and on the evening of May 19 the following program was given:

"The Distillation of Coal with a Miniature Plant in Operation," Harry Peck.
"The Distillation of Coal Tar with Stills in Operation," Raymond Maxon.
"The Manufacture of Sulphuric and Nitric Acids," Loyal Reed.
"The Manufacture of Aniline and Other Dyes," Herman Wright.
"Soap and Glycerine Manufacture," Dora Allaben, Helen Ford.
"The Manufacture of the High Explosives," Clarence Talbot.
"The Manufacture of Phenol and Naphthalene," Graham File.

The results of this open meeting of the Scientific Society were even better than I had hoped they could be. The students taking part learned to look things up, to study the literature on a subject, to work out the laboratory directions for a series of experiments and to go ahead with those experiments. They saw the relation between chemistry and industry as no amount of reading or lecturing could have shown it to them. They became enthusiastic about the subject. At least two boys who had not planned to go on in school are now planning to do so and to specialize in chemistry. The whole town became interested in the work being done at the high school. I felt that it was of so much value to us that it might well be of value to others. Hence the following description of the apparatus necessary and the *procedure* followed:

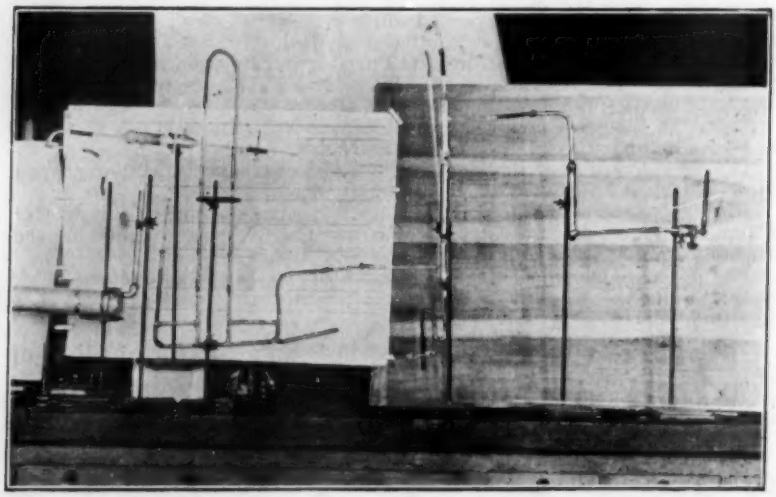

FIGURE 1.

The outline shows the work as we performed it. In the procedure as I am giving it there are certain changes which will, our experience leads me to believe, make the demonstration more practical and none the less interesting.

Apparatus: Gas Plant. *Retort.* A 3 inch gas pipe 10 or 12 inches long was threaded at both ends and capped. One cap was drilled and a 3-8 inch pipe threaded into it. This pipe was turned at right angles, one inch from the cap.

Hydraulic Main. A 6 inch length of 1 inch glass tubing was secured. About two inches from one end a 1-4 inch glass tube was sealed through this tube in such a way that the inner edge almost touched the opposite side of the larger tube. About one inch from this seal a 1-4 inch piece of tubing was sealed to the same side of the large tube. The small tubes were then bent as indicated in the figure. One-holed corks were inserted in each end of the larger tube. A water lead entered through on end. The other end was used as an outlet, through which the tar and ammonical liquor could be drawn off when necessary.

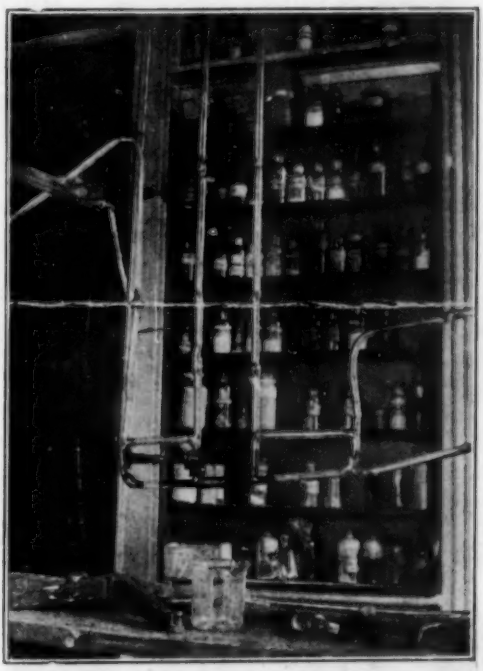

FIGURE 2—HYDRAULIC MAIN AND CONDENSER.
Note water lead entering at back of Hydraulic.

Condenser. This piece of apparatus is made entirely of 1-4 inch glass tubing. A simpler form of the same apparatus could be made as indicated in Figure 3. The gas should be forced to pass through at least twelve feet of this 1-4 inch tubing in the condenser. Even then you will find that some tar will be carried over when the gas is forming rapidly.

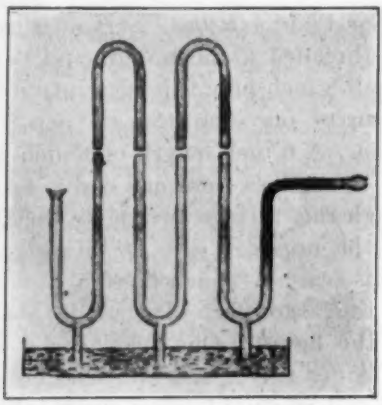

FIGURE 3—SIMPLER FORM OF CONDENSER FOR GAS PLANT.
Twelve feet or more of ¼-inch glass tubing bent as indicated. To the lower end of each loop an outlet 6 inches long is sealed on. These extend at least two inches under water in the trough which represents the tar well. Ground glass joints should be provided at each end of the gas lead.

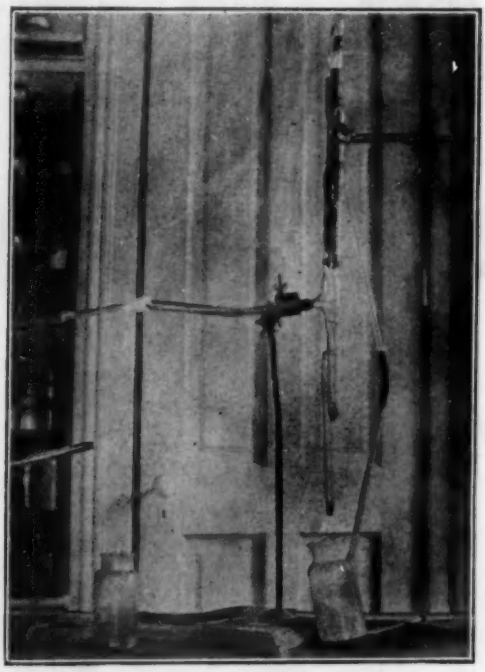

FIGURE 4—SCRUBBER.
Note the water lead behind the rest of the apparatus.

Scrubber. A piece of 1 inch glass tubing was drawn down to one-fourth inch at one end and a 1-4 inch tube was sealed on. This smaller tube was then bent as indicated (Figure 1) to form

a trap. One inch above this seal a 1-4 inch intake was sealed on. Just above this joint the tube was constricted to 1-2 inch diameter. One foot from this joint a 1-4 inch outlet was sealed on. The apparatus was then filled with pieces of charcoal from the constriction up to within one-half inch of the outlet. An inch above the outlet the tube was drawn down to a little less than one-fourth inch. A piece of 1-4 inch tubing was drawn down to form a jet tube and sealed into the upper end of the larger tube, with the jet tube protruding about one-half inch into the apparatus.

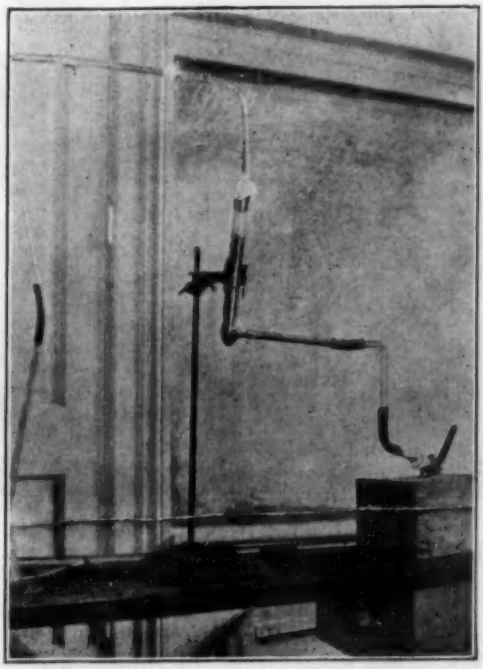

FIGURE 5—PURIFIER AND GAS JET.

Purifier. One inch tubing was used here also. A piece about one foot long was sealed at one end and an outlet sealed on just above the bottom. A 1 inch bulb was blown on a piece of 1-4 inch tubing. The end of the bulb was then blown out. The upper end of the larger tube was flared slightly, and the bulb was ground in as a stopper. This allowed for the recharging of the apparatus. Oxides of lime and iron deposited on wood shavings were used as the charge. They were secured from the local gas plant.

Ground Glass Joints. These were made by blowing a very small bulb on the end of a piece of 1-4 inch glass tubing. By

heating the end of the bulb it was possible to blow out the end. Another piece of tubing of the same diameter was flared, by heating and then forcing over a cone-shaped piece of charcoal. The tubing should be rotated rapidly over the cone, until the glass sets. When the two pieces have cooled, powdered carborundum mixed in vaseline is placed on them and they are ground to fit by rotating one in the other. We considered the grinding complete when the cleaned joint was air tight. Such joints were used between all glass parts of the gas plant, as well as in all places where the use of rubber would be impractical. In setting up the apparatus the joints were fitted tightly and then covered with plaster paris, which prevented slipping.

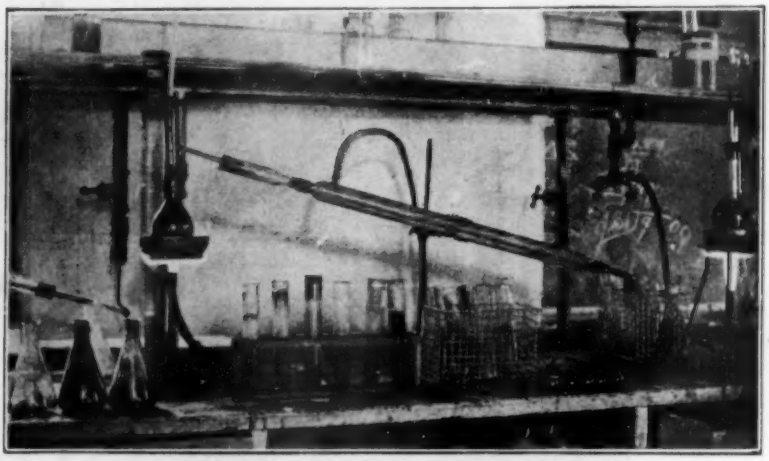

FIGURE 6—THE BENZENE STILL.
Where light oil was redistilled into benzene, etc.

Tar Stills. Distilling flasks were made from ordinary flasks, the necks of which had been broken. After cutting the bottom from a test tube it was sealed onto the broken neck of the flask. The outlet was then sealed into the test tube which is now a part of the neck of the flask.

Condensers. A 30 inch length of 1 inch glass tubing was fitted with two-holed stoppers. A piece of thin-walled 1-4 inch tubing was then inserted through one hold of each stopper. A right angled bend inserted through each of the other holes and connected to the water supply completed this apparatus.

Steam Stills. Any kind of a steam generator may be used. The figure will show the method of connecting. For nitrobenzene and aniline we found that an air cooled condenser

was sufficient. A three foot length of 1-4 inch glass tubing was sealed to the outlet of the distilling flasks.

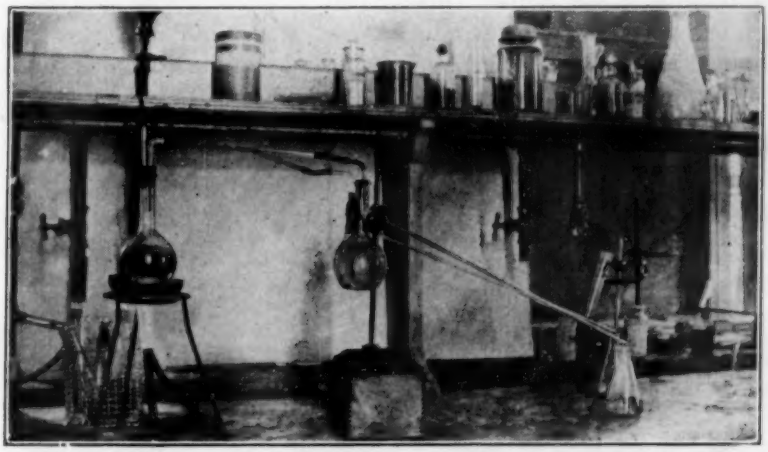

FIGURE 7—STEAM STILLS FOR NITROBENZENE AN ANILINE.D

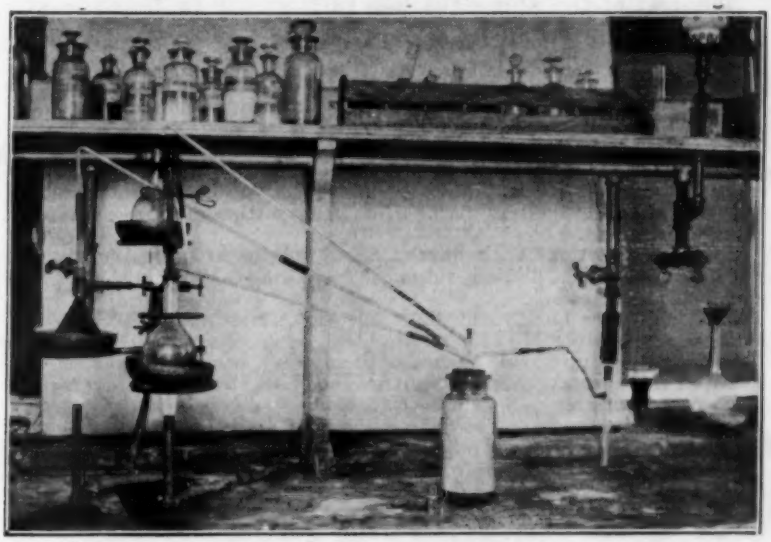

FIGURE 8—SULPHURIC ACID PLANT.

Sulphuric Acid Plant. Our apparatus was a modification of the one described by Garner in his Laboratory Manual.

Separatory Funnels. Inasmuch as our laboratory was not equipped with separatory funnels we constructed our own by taking a piece of tubing just too large to enter the stem of an ordinary Bunsen funnel. This was drawn to a point and sealed. It was then ground to fit as described under "Ground Glass Joints."

Nitric Acid Plant. We used an ordinary tabulated retort, but because a rubber joint would be inadvisable we ground in an extension to the outlet tube. This extension was bent at a right angle and extended into water where our acid was dissolved as formed. Phosphoric acid and sodium (or potassium) nitrate were the charge used.

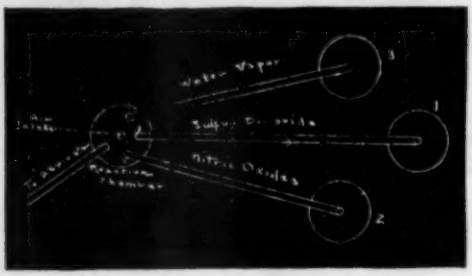

FIGURE 9—PLAN OF SULPHURIC ACID PLANT.
1, Sulphur burner. 2, Flask of Nitric Acid. 3, Flask of Water.

The rest of the apparatus was such as will be found in any school laboratory.

First demonstrator:

Heat retort with blast lamp. Draw tar and ammoniacal liquor as necessary. Separate tar and liquor. After adding lime, distill liquor into water. Test water for ammonia.

Second demonstrator:

1. Distill tar. Test fractions in water. Light oil floats. Middle oil has same sp. gr. as water (approximately). Condenser must be warmed after light oil is over. Heavy oil settles in water. Asphalt remains in retort.

2. Wash fractions with diluted alkali solution to dissolve out the Phenol, then with diluted sulphuric acid. Save washings for fifth demonstrator.

3. Distill fractionally the light oil. Fractions up to 80°; 80°-90°; 90°-100°; 100°-115°; 115°-150°.

4. Fractions up to 90° washed with acid and base and dried may be nitrated as benzene. Six parts nitric, ten parts, sulphuric, seven parts benzene. Mix and cool acids. Add benzene slowly, cooling. Attach reflex condenser and keep at 60° for one hour. Distill *nitrobenzene* with steam after separating and washing.

5. Separate *nitrobenzene* from aqueous layer. Six parts nitrobenzene, three parts hydrochloric acid, two parts granulated tin. Attach reflex condenser. Keep at 60° for one hour, separate, wash, and distill with steam. Separate *aniline oil* from water with separatory funnel.

Third demonstrator:

1. In apparatus as shown in figure make *sulphuric acid.* The sulphur burner consists of an iron pan over which is inverted an ordinary Bunsen funnel. It will be found necessary to keep a Bunsen burner under this pan. The aspirator is started, the sulphur lighted and the chamber becomes charged with a mixture of sulphur dioxide and air. Strong nitric acid has been heated in the side flask and the vapor is now turned into the chamber, after which steam from the third flask is added. The acid condenses and a new run is started.

2. Using a tabulated retort charged with strong sulphuric or phosphoric acid and potassium nitrate, make *nitric acid.* If the end of the outlet tube is simply passed into water the acid will be absorbed as formed.

Fourth demonstrator.

1. Melt one-fourth pound of lard or other fat. Dissolve three ounces of sodium hydroxide. Add solution to the melted fat, heat for one-half hour. Add sodium chloride to salt out the soap. Filter. Press *soap* into cake.

2. Dry glycerine by boiling under reduced pressure. A more complete purification of the glycerine is impractical in the ordinary school laboratory. Hence we purchased the glycerine as well as the phenol, of which we prepared only small amounts, which were used by the sixth demonstrator.

Fifth demonstrator.

1. Take alkali washings from light and middle oils. Add strong sulphuric acid. Phenol crystalizes out. Filter and preserve crystals for test. Test by nitrifying and obtaining yellow of picric acid.

2. Middle oil will contain some crystals of naphthalene. Filter and redistill crystals. *Naphthalene* will be obtained in a fairly pure state.

3. Dissolve *gun cotton* (partly formed, at end of two hours' treatment) obtained from sixth demonstrator in alcohol and ether giving *collodion.*

Sixth demonstrator:

1. Dissolve 2 gr. phenol in 2 cc. strong sulphuric acid by warming; cool and pour the solution slowly into 6 cc. strong nitric acid. When the action has abated, heat on water bath for fifteen minutes, adding a little fuming nitric. Pour into cold water. Gives yellow crystals of *picric acid.*

2. Melt and cast picric acid crystals. Gives *lyddite.*

3. Prepare and cool a mixture of 3 parts fuming nitric acid and 1 part strong sulphuric acid. Cool to 10° C. Place in this mixture a piece of cotton wool. Steep for twenty-four hours. At the end of two hours remove part for fifth demonstrator, part 3. At end of twenty-four hours remove and wash, using dilute sodium carbonate solution, then water. Preserve *gun cotton* in damp condition.

4. Prepare mixture of sulphuric and nitric acid as in 3. Add glycerine to the mixture in a flask. Allow action to start and *immediately* place in cool water bath. (Reflux condenser should be used.) The temperature must be kept below 180° C. When the action ceases the *nitroglycerine* will gather at the top of the mixture. Separate, wash with water, then with dilute sodium carbonate solution, and dry.

5. Wet a few cc. of sawdust with nitroglycerine. The result is one form of *dynamite.*

6. Dissolve a few drops of mercury in an excess of nitric acid. Add ethyl alcohol, then dilute with water. *Mercury fulminate* is thrown down as a grey powder. Wash and dry. Preserve fulminate under water.

7. To 10 cc. ammonium hydroxide add 5 cc. saturated solution of iodine in either alcohol or water—potassium iodide. A black powder is thrown out of solution. Filter and dry (*CARE*). *Nitrogen iodide* is too explosive to be of commercial value. It will detonate when dry if touched with a feather.

Seventh demonstrator:

1. Aniline obtained by second demonstrator (5) is treated with concentrated chromic acid, made by dissolving sodium dichromate in concentrated sulphuric acid. A heavy black ppt. of aniline black will form.

2. Aniline treated with dilute chromic acid will produce a similar ppt. of aniline blue. If the action is stopped at exactly the right moment a fast green will be produced. The blue is, however, often green in color until neutralized in washing.

I should advise that in the ordinary demonstration no attempt be made to go farther than this with the dyes in a connected series of experiments unless there is some one member of the class who has exceptional ability and is particularly interested n this line of work. In that case any of the organic laboratory

texts will supply the directions for carrying the process through to methylene blue. I should never again try to make up the dimethyaniline. It requires too extensive a side line and can be secured from the supply houses.

Among the teaching profession there will be some who will doubt the wisdom of allowing high-school pupils to attack such problems as these. They will tell that the pupils will get little or no idea of the chemistry involved. And, of course, many of the actions are beyond them. But I feel that the interest aroused, even if there were no gain in chemical knowledge, makes this class of work very much worth while. Nor am I ready to admit that there is no gain in chemical knowledge.

STUDIES BY THE GEOLOGICAL SURVEY.

Mapping from the Air.

Requests made to the United States Geological Survey, Department of the Interior, for information concerning the possibilities of photographic surveying from airplanes or other aircraft have recently become so numerous that it is deemed necessary to issue a statement on this subject. For two years the United States Geological Survey, which prepares and publishes more maps than any other organization in the world, has devoted much time and labor to the study of problems to be solved in photo-aerial surveying. The camera has long been used in surveys on the ground, and the Geological Survey has been making studies to determine the best methods of using it in aerial work. Before the war the panoramic camera was employed by the Geological Survey for mapping in Alaska, and it had been widely used for photographic surveying in Canada and in Europe. Aerial photographic surveying involves no new principles, yet it differs essentially from photographic surveying on the ground, for the line of view from a camera in a balloon or an airplane is vertical, not horizontal. A complete statement of the Geological Survey's investigations in photographic mapping from the air will later be prepared for publication.

"Mosaic Maps" Not Accurate.

The principal object in an aerial survey is to obtain on a horizontal plate or film a picture of the area below the camera. If the area is itself a plane the picture of it taken from an airplane on such a plate is a true map, but no apparatus has yet been devised that will maintain the plate in a truly horizontal position when the airplane is in motion; and, as the earth's surface is almost nowhere plane, the photograph must be corrected to obtain a map free from distortion. The nearest approach to an aerial map so far made is the so-called "mosaic map," which is really not a map at all but merely a patchwork of photographs. The pictures composing such a mosaic show distortions, due partly to the deviation of the plate from the horizontal position and partly to relief in the surface photographed, and these distortions render the picture useless for accurate map construction. Distorted photographs of an area that has been previously mapped can be laid down over a network of points whose positions are known, and by distributing the errors due to distortion a mosiac may be constructed that will present a good appearance. For correcting and revising older maps by the addition of culture, timber areas, new roads, and similar features such mosaics have a distinct value, but they are worth little as material for use in constructing new maps.

THE PROJECT IN GENERAL SCIENCE.

By WILLIAM SAYLES WAKE,
Blewett Junior High School, St. Louis, Mo.

NEED OF THE PROJECT.

In recent years we have noted the attack on formal discipline; we have noted the fallacy of the "carry over" and the resulting transition into new types of teaching. Since learning one thing does not mean that you know another, since learning a physical law does not mean that you understand its applicatons and significance, the educator of the child is required to be specific. As a result, the old traditional subjects are losing ground or undergoing a radical change in their point of view. The revised and enlarged curriculum is much closer to the pupil and to life situations. The conviction is deepening that the knowledge gained by the pupils should be created largely by their own study. It is the easiest thing for the teacher to use the lecture method and tell the pupils what they ought to know. The difficulty with this plan is that the telling does not guarantee that the hearer gets what is being told. The pupils, and especially is this true of the younger pupils, are not able to digest and make over as their own the things they hear.

THE LABORATORY.

In order to supplement the telling or lecture method, the laboratory, which is a comparatively recent addition to schools, was brought in. This was such an improvement that the laboratory and its methods have been left largely as they came into being. The trouble with the laboratory and its methods has been that the things done have not been what the nature of the learner demands. The pupil could not recognize the things he did as his problems. They might be of some use to him some day since the problems were largely the problems of the adult, and interest and enthusiasm were very largely lacking.

THE PROJECT.

So the plow of educational progress was set deeper in order to bring to light more basic and fundamental truths. The deeper investigation reveals that there is something more important than the teaching of facts and theories. This or that is not absolutely essential in the life of anyone. Even though there is no fact or theory that is absolutely essential, there are several things that are highly desirable. He should learn (1) how to act with his fellows. He should (2) know the tools with

which men work in society. He should learn how to be a more confident, intelligent worker in society. To bring about these ends we have socialized work, supervised study, and the encouragement of self-activity in education. We are more concerned about the development of the child than we are about facts and theories. But the result is that when the welfare of the development of the child is more properly cared for, there is a corresponding increase in the capacity of the pupil to get and use the facts and theories. Connected with this new point of view is the project. The most enthusiastic supporters of it declare it to be the only really desirable form of teaching, while others have called it almost everything else. It seems quite evident that all project teaching is not alike and that the actual ideals for classroom procedure are uncertain and undefined. In any argument or discussion, the definition of terms is of first importance. The following definitions of the project have been offered.

Snedden: "A project is a unit of educative work in which the most prominent feature is some form of positive or concrete achievement."

Drushel: "A project is a concrete problem outlined sufficiently fully and clearly to enable the student for whom it is designed to carry it out."

Woodhull: "It is not a device for getting a hold on deficient students and keeping them from making trouble. It is not some new thing. It is not something to be stereotyped and printed in a book to be memorized by a million unhappy pupils. It is not soft pedagogy, or a hodge-podge, or an unorganized mass, or a royal road to learning. The project must always arise in some cross-road situation, some doubt as to the next step, some question vital and impelling because of its personal interest."

Hosic: "The problem-project method is an attempt to carry out the spirit of democracy and at the same time apply the principles of learning, i. e., a method of purposeful experience."

Bobbitt: "Projects are experiences of the work type."

Randall: "A school project is a problem the solution of which results in the projection of some object of knowledge of such value to the worker as to make the labor involved seem to him worth while."

Stevenson: "A project is a problematic act carried to completion in its natural setting."

Nolan: "A project is a reflective act carried on in its natural setting."

Kilpatrick: "A project is a whole-hearted, purposeful activity proceeding in a social environment."

As I studied these definitions I was reminded of the boy at the Thanksgiving dinner who remarked, "I can chew but I can't swallow." The trouble seems to be that there is an attempt to cram too much into a definition. Is it not advisble to separate the meaning of the word "project" from its meaning in special use? The "how" and the "why" are special matters and cloud the idea of the project, and the manner of its use in school, when crowded into a definition. Let the meaning of the word "project" stand by itself, and the manner in which the project may be used may be discussed separately. Special

attention may then be given to peculiar conditions that obtain in the teaching of various subjects.

Let us examine each of the above definitions separately. (Snedden) This is a very usable definition, but it is special and not general in the manner in which it defines. There are other projects than educative units. (Drushel) There are other projects than projects of the student. (Woodhull) This could hardly be called a definition. (Hosic) This definition seems rather indefinite. (Bobbitt) The project is not an experience but a plan of action. (Randall) Projection of some object or knowledge may be compared with "plan of action." (Stevenson) The natural setting is not possible in every case of school work and the definition should not limit, where limitation is not necessary. Or, the definition is incomplete without a definition of the meaning of natural setting. (Nolan) This definition holds the project to the natural setting. (Kilpatrick) The activity is the working out of the project. A project must project. It therefore must be a plan of action looking into the future. It is also possible to have a project that does not proceed in a social environment, and therefore needlessly limits.

Is it not desirable to be general in the definition of the term project and specific in indicating the manner of its application in educative work? For such a purpose would you consider the definition, "A project is a plan of action, which when carried out results in a thing accomplished"? Do I hear you say, "Such definition leaves out the modern educational point of view"? Yes, it does and rightfully so, for the definition should not necessarily include the manner of use. The use of the project in modern science teaching is more than one should attempt to include in a definition. How the project is to be used in the teaching of various subjects according to modern pedagogy is a thing that cannot be universalized and held under a single definition. It is a study and an art in itself and should be considered in detail.

The Approach.

The tendency in the past has often been to bring the pupil to a school problem before the child was ready for such a problem. The pupil has been told, "Well, you are not interested now, we know, but it will do you a lot of good later on. Some obedient pupils did the work because they could and were willing and trusted in the opinions and advice of their elders. The best schooling is not merely preparation for life; it means

life itself and child life in its fullness. We are coming to believe that what a pupil should study and how he should study it should not be dictated by the wise (?) adult, but that it must be dictated by the nature of the child and the requirements of his environment. If the pupil can study in a manner that is in harmony with his nature, he will like it. It is a difficult matter to believe that we can discover so vitally the needs of a pupil that he will recognize them in detail as his needs and enter whole-heartedly into their realization. It is also hard to believe that we can discover a way of teaching him, i. e., satisfying those needs, so that it will compel the whole-hearted activity of every pupil. But these are the very things that we are attempting to do. This attempt (project) is a big one, and while parts of it may be realized, the main project will be continually worked out as long as mankind continues to develop.

The Beginning of the Project.

If, then, the ideal is realized and we offer a pupil the satisfaction of his real needs, he must enter whole-heartedly into the work or break faith with himself. The project may involve real problems of the pupil, whether suggested by himself or by the teacher. The approach to the project should cause a pupil to feel that he is dealing with things that are near at hand, socially fundamental, and for him worth while. The matter of the anticipation of pupils' questions and problems is well illustrated by the Book of Knowledge and the World Book. Pupils have asked these questions and pupils yet unborn will ask them. One may have to tell them of some of these things or they would never know about them or become interested in them, but such is the regular part of the "approach" or "preparation" of the lesson. When the pupil recognizes his project he is ready to begin.

The Development of the Project.

At the beginning the plan of action may be very indefinite, but, by thought and reading, a plan of action must be decided upon. The work may proceed with the pupils working in groups or as individuals. The teacher is necessary to guide the reading and activity. The literature in science for such a procedure with young pupils is woefully inadequate, and they must be given constant help. An outline or bibliography may be placed in the hands of the pupils, or manuscripts may be prepared specially for the purpose. The work may consist of reading, experimentation, and discussion. There are times when a

demonstration is needed by the teacher, followed by an attempt by the pupils to try the same thing. There are times when they need to be shown how. They may then try it for themselves later, in school or after school, as the instance may require. The incentive to the pupils by the knowledge that they are going to "show something" (demonstrate) to the class is a excellent form of motivation of the work. The pupils who demonstrate come to know the project and what it involves very thoroughly, and at the same time those seeing the demonstration realize that what is being done they also may do. The result is that many go home and try it. The fact that the one group is not working entirely for itself but for the whole class is an excellent way of socializing the work.

Culmination of the Project.

For school work one form of culmination of the project is the demonstration by the pupils to the class. They are in control of both the demonstration and the discussion. Such procedure insures the activity of the pupils. They insist on an explanation that explains to them. Since the discussion and argument are in their hands, the point of view of the work is theirs. "There is no use to argue with the teacher," they may say, but when they are talking and working by themselves there is an equality in the exchange of ideas that is stimulating. The teacher is necessarily present to guide and instruct and keep the work efficient. It may be pointed out that the natural setting and socialization are extremely valuable, but the socialization and natural setting may both be absent and there may still be a project even though it is not an ideal project.

The Close of the Project.

The project closes when the thing attempted has been accomplished. In the working out of the project the following results may be expected: Experience, knowledge, formation of habits (skill), attitudes, and feelings.

The Attitude.

A new attitude is produced in this type of work. The fact that the pupil has done things of a scientific nature, gained a familiarity with scientific terms, books, and apparatus enables him to feel at home in work. The project has permitted him to go deeply enough into the matter so that he has a personal satisfaction in what he has done, made, or learned. The fact that he has done something successfully gives him encourage-

ment to try something else. A part he has mastered and used for his own ends. He may see science in its true relationship to mankind. It is his ally if he will but make it his own. New fields are opened up before him heretofore unheard of. The work is to him worth while; so he endeavors to carry it on at home, where he continues the work of reading, experimentation, and demonstration to friends. The project method at its best stimulates the activity of the pupil rather than compels a passive and receptive attitude. If it happens that in science he has found himself, the trouble to which he will put himself to work out his ideas is extreme. For instance, one boy is studying sugars. He found the formula of sucrose, maltose, and lactose to be the same. He wanted to know how there could be a difference of properties when the formula was the same. He is willing to go as far as necessary and is now trying to understand isomerism. Dextrose and levulose also have the same formula, and he is going to study polarized light to find satisfaction for his problems. The encouraging thing about it is that he will get satisfaction if it is at all within his grasp to get. What is this seventh grader going to be when he is grown? What difference will it make to him and others if he is encouraged or discouraged in his work? Are we ready to permit the genius to develop while in school?

Types of Class Procedure in the Project Method.

Educators have declared that the project method is the only real method of teaching. Some have hailed the project method as something new, something radical. But the big difference is in the point of view. This new point of view must take into complete consideration the nature of those being taught. Good teaching as we have known it has its place. The teacher's problem arises when the attempt is made to meet the pupil on a basis of his own nature. The extent to which we can realize the true nature of the child is variable, and susceptible to difference of opinion, but as long as the teacher fixes definitely in mind the goal toward which we are working, continued study is going to reveal more and more of how that ideal may be realized. The pedagogy of the past has not been so seriously at fault that the whole science of teaching is going to be revolutionized. In the pupil's study of the project, there will be times when he must be (1) told (lecture method), and times when he must be (2) shown (demonstration or object lesson). There are times when he may (3) work inductively and (4) deductively. He

may be (5) ready for the appreciation of nature and the works of man. He learns to do by doing and by letting him do he (6) develops skill (formation of habits). At times he will have to be shown how to (7) study his problem (supervised study). He may not know what to do next and so there will need to be (8) the assignment of the lesson. The teacher and pupils will want to know what has been done so there must be (9) the report or recitation. Since repetition is necessary to fix things in one's mind there will be (10) the drill and (11) the review. And because the pupil is to become a confident, intelligent member of society, the work must be (12) socialized. The aspects of good teaching are not to be lost sight of, for they are fundamental and will find a place in project teaching. The change is chiefly in the point of view. We are now to assist the pupil in his development. Human nature has not changed, and the laws governing the exchange of ideas will not change. The change will be in the manner of the application. Since the problem is to be made real to the pupil, a premium is to be placed on the natural setting of the problem. But it may be that the natural life setting will have to be modified for school use. There always will be, as there always has been, a premium placed upon the teacher who can effect the "bringing out" of the pupil. The teacher must be a greater teacher than ever before. The path is not the narrow one to which, in days gone by, the pupil could be held. The teacher's knowledge must circumscribe the pupil's needs. A more thorough understanding of the subject and of the relation of that subject to life itself is absolutely imperative.

Inductive and Deductive Method.

The inductive and deductive method each has its place. The inductive method may be employed in the project and will have at least four steps. First, the preparation of the class for the project would involve the gathering of facts and the recognition of the problem. Second, there must be a gathering together of the facts. Third, there must be a comparison and interpretation of the facts. And, fourth, there must be the generalization, or formulation of the law. We have the instance of the teacher who placed a block of wood before a pupil and kept him studying it expecting him to eventually formulate Newton's first law of motion, which is, "Every body continues in a state of rest or of uniform motion in a straight line until compelled by some external force to change that state." It is evident the pupils

need help. Starting with a problem, "Why does an automobile skid when going around a corner?" the pupil could be guided in his work by manuscript or outline to examine his experience in comparable instances; for instance, a ball whirling on the end of string, centrifugal pumps, force necessary to stop a moving object slowly, force necessary to stop a moving object rapidly, and so forth. From a careful consideration of these facts he could be made to see the manner of behavior of matter under these circumstances and formulate, or be ready to accept as his own, the law as Newton stated it. This takes more time, but the pupil knows thoroughly what he does know. On the other hand, the pupil could have been referred immediately to Newton's laws and set to work at the task of verifying them. It is hardly necessary to say that the presentation of the law at first is a less real life experience than when the law comes after the appreciation and comparison of related facts. There are times, though, when circumstances require its use. For instance, a pupil might want to measure the depth of a well or pit. He could look up the law (formula), make the necessary substitutions, and get the answer. The derivation of the law would be beyond the pupil, but the use of the formula would not. Care should be taken in the use of deduction not to refer to principles when the pupils do not possess them.

The Textbook.

As the discussion in detail of the desirable text for project science would be lengthy in the extreme, little may be said here. There should be some unity in the background tying the projects together. That unity will be very readily given by the pupil, for he demands it: It need not be a forced unity. The text should not cause the pupil to be awestruck at the achievements of science, but should seek to give confidence and a familiar working attitude. The subject matter must be fundamental, desirable, and necessary to a harmonious order of society. Above all, it must harmonize with the age of the pupil, aims of the project, and the laws of modern pedagogy.

USE OF ASPHALT IN PAVING.

Asphalt is most largely used in this country in paving city streets and country roads, and, though its utilization in road building in 1918 was restricted chiefly to the maintenance of existing pavements and to new construction at cantonments, shipyards, and elsewhere in war work, a larger quantity of paving asphalt, binder, filler, road oil, and flux was made from petroleum and crude native asphalt and sold last year than had been sold in any one year preceding the war.

WHAT STANDARD TESTS IN SCIENCE SHOULD DO.[1]

By ELLIOT R. DOWNING.

It is a rather curious fact that we teachers of science have been among the last of the teaching fraternity to undertake the formulation of tests or objective standards for measuring the efficiency of our instruction, for the whole modern movement of measuring educational products is merely the application of the scientific method to education. If you were asked to pass judgment as a biologist on the relative rate of respiration of a plant and an animal or the relative intelligence of a horse and a dog, you would not for a moment be content with an opinion based merely on observation of their behavior, but you would hold yourself to some rigidly precise experimentation, the results of which would be capable of expression in exact and comparable terms—experiments that could be repeated by any other interested investigator. In other words, we have, as scientists, long ago passed the stage at which we were content with subjective opinions based on personal interpretation of phenomena, and we insist on objective standards that may be used with certainty by all in securing data for judgments. The standard test is merely the application of biometrics to the school. As educators, we are coming to subscribe to a principle that has long had our allegiance as scientists, that no science can be considered an exact science until it is capable of mathematical expression. It seems strange, therefore, that the science teacher, who is supposed to have achieved the scientific attitude of mind, has been almost the last of the school men to see that there are problems in the pedagogy of science and that the same scientific method on which he relies in science is the only one by which they can be solved. Possibly we have here only another illustration of the non-transfer of training—possibly the scientist is so impressed with the complexity of the problems that he is loath to undertake them.

In general we may anticipate that standardized tests will do for the teaching of science what they have done and are doing for the teaching of other common school subjects. To be specific, we may expect that the standardized test in science will

First, substitute objective standards capable of mathematical expression in their application for the varied subjective and therefore indefinite standards that maintain at present. Let me illustrate from a subject in which objective standards are

[1]Paper read before Biology Section of University High School Conference, Chicago, May 9, 1919.

available. The pupil whom Grade 4 teacher marks "superior" in writing, Grade 5 teacher may mark "poor" when he passes to her room because "superior" and "poor" have quite unlike meanings to the two teachers. Their standards are subjective. But now if the Freeman or Ayer handwriting scale is used as a standard the judgments of both teachers will coincide.

In many schools we have taken temporary refuge in the "normal curve" and the "expected distribution of variates" as a scientific basis for checking up our subjective judgments. It is a system that is reasonably accurate if our pupils are average pupils, but that fails if the class is exceptionally brilliant or stupid. Still, even with such extremes, the results are more nearly fair than when we rely merely on the unchecked opinion of the teacher whose final grade to a pupil is quite as likely to be influenced by a spell of indigestion and the consequent headache at the close of a semester as by the real performance of the pupil. We recognize that at best the method is merely palliative until such time as we do have standardized tests that will give us objective bases for judgment.

Second, the attempt to formulate standardized tests will force us to a clear definition of the aims to be achieved by science instruction, for you cannot work out a method of measuring a thing until you have a very exact concept of what it is you are trying to measure. Again let me illustrate from what is now past history in the testing movement.

The formulation of tests in spelling necessitated a clarification of purposes. The old spellers were made up in large measure of lists of words that were unusual and that were selected merely because they were difficult to spell. The spelling test forced a realization that spelling drill must be confined to words that are really needed in actual use and these were found by going over a mass of business correspondence and selecting the ones most frequently occurring. The object of instruction in spelling is not mental gymnastics but accuracy in the written words commonly needed.

The old penmanship copy books were full of flourishes—a redundancy of ornate elegance. The formulation of tests made it apparent that the criterion of good handwriting is its legibility, and that school drills must be devoted to accomplishing this in the least possible time and assure speed to the pupil as well.

When tests were devised in arithmetic it helped to define the

purpose and consequently the content of arithmetic instruction. It became evident that cube root, partial payments and other subjects that we of an older generation puzzled over interminably gave nothing that was worth while in real life. Such clutter was discarded and the arithmetic work in vogue now on which tests are based deals with fundamental concepts, processes and problems.

We must then define our aims in science teaching in order to formulate tests. If we are attempting to develop ability to see and solve problems the tests must be devised to measure the amount of such ability the pupils acquire. If we are trying primarily to impart a fund of information, the test must be of quite a different type. If the aim is to give to the pupil an aesthetic and intellectual appreciation of the commonplace environment, then the tests must be such as will snow how far the instruction is successful.

Third, we must be even more specific. The appropriate aims must be formulated for each stage of instruction. The list of words selected for spelling drills in the first grade is quite different from that for the fifth. The teacher of primary reading is largely concerned with putting meaning into words, making sure that the mental imagery associated with symbols i correct. The sixth-grade teacher is more concerned with the grasp of ideas expressive of relations. The scientific method of thinking is a complex process made up of many elements. There is included in it the accumulation of sensory experiences, analysis, synthesis, the registration of facts, the perception of queer or perplexing relations, the formulation of a guess or hypothesis in explanation, observation to a purpose, possibly experimentation, reasoning, and the formulation of judgment. The process may be established as a habit, it may be made rationalized habit, it may be adopted as an ideal method of procedure. Shall we undertake to accomplish all these things at once, or are children particularly apt at some of the involved elements at certain stages of their development so that we can focus attention on certain elements at one level of education, on others at another stage?

If information is to be acquired it must similarly be determined what information is to be attempted at each level. This will depend on the pupil's interest, capacity, social needs, etc.

It is evident from even such a cursory view of the situation that the problem of the organization of science instruction is

no mean one, that it involves the accumulation of a mass of information much of which we do not yet possess and that the principles involved must be worked out patiently as must those involved in any other scientific problem.

Fourth, the application of tests to science teaching will necessarily force us to a careful reconsideration of methods. When a well devised writing scale is applied to a school system and it is found that the results show the school in question scores much below the normal standard, at once the method of instruction must be carefully scrutinized to find out the reasons for the failure. Suppose that we could come to an agreement on ten or twenty important biological generalizations that should be clearly in the minds of pupils after the high-school course, such as a clearcut notion of evolution, Mendel's laws, the cell as the unit of structure and function, of the adjustment of organs to function, the adaptation of the organism to its environment, the differentiation of structure and the concomitant specialization of function, topics that are treated in the main in every textbook. Then suppose we could agree on some tests on these items and could standardize them. The results would facilitate the evaluation of the work of a given school or a given teacher. Such a standardized test would at once eliminate the ambiguity that pertains to grades now given. For the scoring would not represent the individual teacher's judgment of pupils' attainments on the basis of his personal ideas of what should be accomplished but would represent a grade of attainment capable of comparison with that of other teachers and other schools. Such a survey of present accomplishment on the basis of current texts and methods would be very worth while. The results would undoubtedly be a revelation of inefficiency, as the standardized tests have been almost universally. Such a test would have, too, only temporary value, for it can scarcely be doubted that the aims, methods, and materials of science instruction will change with revolutionary rapidity once we start the testing process. But its immediate value would be immense. It would force immediately investigation of the best methods to get these generalizations over into the minds of the pupils.

SMALL OUTPUT OF DRAINTILE.

Draintile is used principally in the improvement of farm lands in the Central States, where large quantities of it are laid annually. Notwithstanding the efforts to increase agricultural endeavors, its decrease in value in 1918 was $3,620,000, or thirty-three per cent. The output in 1918 was valued at $7,388,000, which, with proper allowance for increased cost, was probably the smallest output since 1903.

PROBLEM DEPARTMENT.

Conducted by J. O. Hassler.

Crane Technical High School and Junior College, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. O. Hassler, 2337 W. 108th Place, Chicago.

SOLUTION OF PROBLEMS.

Algebra.

606. *Proposed by Daniel Kreth, Wellman, Ia.*

What six numbers in geometrical progression are those of which the sum of the extremes is 99 and the sum of the other four terms 90?

I. *Solution by R. M. Mathews, Duluth, Minn., A. H. Gretsch, New Bedford, Mass., M. G. Schucker, Pittsburgh, Pa., and Norman Anning, Meaford, Ontario.*

Let a be the first term and r be the constant ratio. Then $a(1+r^5) = 99$. $a(r+r^2+r^3+r^4) = 90$

whence $$\frac{r+r^2+r^3+r^4}{1+r^5} = \frac{10}{11},$$

and $$10r^5-11r^4-11r^3-11r^2-11r+10 = 0.$$

The roots of this equation are

$$r = \tfrac{1}{2}, 2, -1, \frac{-1\pm 2\sqrt{-6}}{5}$$

For $r = 2$, $a = 3$ and the progression is $3+6+12+24+48+96$.

For $r = \frac{1}{2}$, the progression is the preceding one read backward.

For $r = -1$, $a = \infty$, an improper solution.

For $r = \dfrac{-1+2\sqrt{-6}}{5}$, $a = \dfrac{99}{1+r^5} = \dfrac{9(22-31\sqrt{-6})}{4}$ and the progression is $\dfrac{9(22-31\sqrt{-6})}{4} + \dfrac{9(70+15\sqrt{-6})}{4} + \dfrac{9(-50+25\sqrt{-6})}{4} + \dfrac{9(-50-25\sqrt{-6})}{4} + \dfrac{9(70-15\sqrt{-6})}{4} + \dfrac{9(22+31\sqrt{-6})}{4}$.

For $r = \dfrac{-1-2\sqrt{-6}}{5}$, the progression is the preceding one read backward.

II. *Solution by A. Pelletier, Ecole Polytechnique, Montreal, Quebec, C. E. Githens, Wheeling, W. Va., and Walter R. Warne, Carlisle, Pa.*

$$10r^5-11r^4-11r^3-11r^2-11r+10 = 0.$$

[This was derived as in solution I.—*Editor.*]

Removing from (1) the extraneous root, $r = -1$, we get

$$10r^4-21r^3+10r^2-21r+10 = 0.$$

This is a reciprocal equation.

$10(r+1/r)^2-21(r+1/r)-10 = 0$, and $r+1/r = 5/2$ or $-2/5$ whence $r = 2$, $\frac{1}{2}$ and $\dfrac{-1+2\sqrt{6}i}{5}$.

When $r = 2$, $a = 3$, and the G. P. is 3:6:12:24:48:96.

When $r = 1/2$, $a = 96$, and the G. P. is 96:48:24:12:6:3.

For the imaginary values of r we obtain imaginary numbers, which are also in geometric progression.

Also solved by William H. Brown, W. T. Harlow, G. I. Hopkins, F. Howard, M. J. Leventhal, R. T. McGregor, N. P. Pandya *and* H. C. Whittaker.

607. *Proposed by M. H. Pearson, Sidney Lanier High School, Montgomery, Ala.*

A man sent five men out with 20, 40, 60, 80, and 100 apples, respectively, asking that each one sell some at one fixed price and the rest at another, and that each man collect exactly one dollar. Find the two prices.

Solution by N. P. Pandya, Amreli (Kathiawad), India.

Let x be the higher price, and y the lower, in cents. Let k be the number of apples sold at x cents (and therefore $20-k$ the number of apples sold at y cents), as sold by the first man.

The second man will have to sell a number less than k ($k-z$, say) at the higher price, and $40-k+z$ at y cents.

Let the third man sell $k-v$ at x cents, and therefore $60-k+v$ at y cents.

Then we have
$$\left.\begin{aligned} kx+(20-k)y &= 100 \\ (k-z)x+(40-k+z)y &= 100 \\ (k-v)x+(60-k+v)y &= 100. \end{aligned}\right\} \quad \text{(A)}$$

These give $v=2z$; thus the third man sells $k-2z$ at x cents.

Similarly, the fourth man sells $k-3z$, and the fifth man $k-4z$ at x cents.

If the men are A, B, C, D, E, respectively, we have the following table:

Seller.	*Total No.*	*At x Cents.*	*At y Cents.*
A	20	k	$20-k$
B	40	$k-z$	$40-k+z$
C	60	$k-2z$	$60-k+2z$
D	80	$k-3z$	$80-k+3z$
E	100	$k-4z$	$100-k+4z$

Thus the x-cents numbers are in an A. P. with $-z$ as the common difference; and y-cents numbers are in an A. P. with $20+z$ as the common difference.

Further, all the x-cents numbers and y-cents numbers are integers. Therefore z is an integer and cannot be less than one.

Again, k is not greater than 20, and the lowest x-cents number is $k-4z$; $\therefore 4z \geqslant 20$; $\therefore z \geqslant 5$.

$\therefore$ if the lower price, $y \neq 0$, z has one of the four integral values 1, 2, 3, 4, and the highest value of k is 19; $\therefore k$ has all values from 19 to 5 (integral) because $k-4z$ is positive.

Moreover, the lowest value of $x > 100/k > 100/20 = 5$.

Moreover, the highest value of $y < 100/100 = 1$.

$\therefore$ the lowest value of $x/y > 5/1 = 5$.

From the equations (A), we get $x/y = \dfrac{20+z}{z}$.

$\therefore$ taking $z = 1, 2, 3, 4$, respectively, we get $x/y = 21, 11, 23/3, 6$, respectively.

By substitution in the original equations, and by the necessary elimination and reduction, we find that the corresponding values may be thus tabulated:

z	x	y	k
1	$\dfrac{105}{k+1}$	$\dfrac{5}{k+1}$	5 to 19
2	$\dfrac{110}{k+2}$	$\dfrac{10}{k+2}$	9 to 19
3	$\dfrac{115}{k+3}$	$\dfrac{15}{k+3}$	13 to 19
4	$\dfrac{120}{k+4}$	$\dfrac{20}{k+4}$	17 to 19

since $y > 1$.

Thus there are 36 sets of corresponding values of x and y.

The values may be found by substituting for k.

[At the conclusion of a solution similar to the above, A. H. Gretsch adds the following.—*Editor.*]

II. *Remarks by A. H. Gretsch, New Bedford, Mass.*

Answers: ∴ The five men sell 18, 16, 14, 12, and 10 apples respectively, at the rate of 2 for 11 cents, and 2, 24, 46, 68, and 90 apples, respectively, at the rate of 2 for 1 cent.

Or they sell 14, 13, 12, 11, and 10 apples, respectively, at the rate of 7 cents per apple, and 6, 27, 48, 69, and 90 apples, respectively, at the rate of 3 for 1 cent.

Or they sell 9, 7, 5, 3, and 1 apples, respectively, at the rate of 10 cents per apple, and 11, 33, 55, 77, and 99 apples, respectively, at the rate of 11 apples for 10 cents.

Or they sell 6, 5, 4, 3, and 2 apples, respectively, at the rate of 15 cents per apple, and 14, 35, 56, 77, and 98 apples, respectively, at the rate of 7 apples for 5 cents.

The other 32 sets are theoretically but not practically possible.

Also solved by A. PELLETIER *and* THE PROPOSER *and there were three incomplete solutions.*

Geometry

608. *Explanation.* This problem was the same as 603 and in the succeeding issue a 603*b* (should have been 608*b*) was substituted. The solutions which follow are for 603*b*.—*Editor.*

603*b*. To draw a circle through a given point tangent to a given line and a given circle.

I. *Solution by A. Pelletier, Ecole Polytechnique, Montreal, Can.*

Traditional solution: Let O, BC, and A be the given circle, line and point. Draw the diameter DOE perpendicular to BC, cutting BC at F. Construct the circle FEA. Join DA, cutting circle FEA at P. The problem is reduced to that of constructing a circle passing through A and P, and tangent to BC, a well known construction. Two circles can be described. If we take DP′ = DP on AB produced, two more solutions are generally obtained.

Note: To construct a circle passing through two given points A and B and tangent to a line CD. The tangent and secant method is generally used, but the mere knowledge of the inscribed angle is enough to solve the problem. For, if we take the symmetrical B′ of B (B, the point nearest CD) with respect to CD and produce AB to meet CD at C, it can easily be proved that the circle passing through A and B′, cutting the line at M and N, will give the two points of tangency (M and N), provided $<AMB'$ be the supplement of the known angle ACD.

II. *Second solution by A. Pelletier.*

Let O, BC and A be the given circle, line and point.

From A draw AT tangent to the circle O; also from A draw AF perpendicular to BC, and produce to K so that $AF \cdot AK = \overline{AT}^2$. On AK as a diameter describe a circle, then draw DE tangent to the two circles. Join AD, AE, cutting the circle O at M, and line BC at N. The circle AMN is the required circle, as is evident from the theory of inversion.

As four tangents can be drawn to the two circles, the problem has four solutions.

Also solved by R. M. MATHEWS, WALTER R. WARNE *and* R. SCIOBERETI.

609. *Proposed by Harris F. MacNeish, College of the City of New York.*

Through a given point draw a straight line cutting a given straight line and a given circle such that the part of the line between the point and the given line may be equal to the part within the given circle. (Phillips and Fisher: *Plane Geometry, Ex. 50.*)

[No solution of this problem by elementary synthetic geometry has been received.—*Editor.*]

610. *Proposed by Murray J. Leventhal, Stuyvesant High School, New York City.*

From a point O in an equilateral triangle ABC the distances to the vertices were measured and found to be OB = 3, OC = 4, OA = 5. Find the area of the triangle.

I. *Solution by M. G. Schucker, Pittsburgh, Pa.*

Place OAC and OBC so that AC will coincide with its equal, BC, point A with point B, but so that OB and OA will lie on opposite sides of the line CA. The figure OCO'A can readily be divided into an equilateral triangle and a right triangle of areas $16\sqrt{3}/4$ and 6, respectively. Likewise, figures formed of OAB and OBC and of OAB and OAC have areas $6+9\sqrt{3}/4$ and $6+25\sqrt{3}/4$, respectively. The area of the given triangle is one-half the sum of these three areas, or $9+25\sqrt{3}/4$.

The Editor is indebted to Professor W. R. Warne for the following references to this problem: Perkins' *Geometry;* Olney's *Geometry; American Mathematical Monthly,* Vol. XII, No. 3 (March, 1905), Vol. XIX, Nos. 8, 9 (August, September, 1912), Vol. XXV, No. 1 (January, 1918).

Also solved by J. Carl Kamplain, W. T. Harlow, F. Howard, W. W. Johnson, N. P. Pandya, S. H. Parsons, A. Pelletier, *and* Walter R. Warne.

Late Solutions.

591, 593, G. R. Narayana Ayyar.
595. G. R. Narayana Ayyar, B. Naga Rajan.
590, 597, 598 (by conics), 599 (by Anal. Geom.). N. P. Pandya.
600. N. P. Pandya and one incorrect solution.
601. N. P. Pandya, S. Rama Chandran.
602, 604. N. P. Pandya.
603. N. P. Pandya, R. Sciobereti, A. Pelletier.
605. N. P. Pandya, S. Rama Chandran, E. J. Oglesby.

Problems for Solution.

621. *Proposed by Louis Sklar, Philadelphia, Pa.*

Solve:
$$y^2-z^2+2xy+2yz = 5 \quad (1)$$
$$x^2-y^2+2yz-2xz = -5 \quad (2)$$
$$2x+y-z = 1 \quad (3)$$

622. *Proposed by A. Pelletier, Montreal, Can.*

For what values of x will x^2+x be a square? Give a systematic procedure to derive these values.

623. *Proposed by C. E. Githens, Wheeling, W. Va.*

The three roots of a cubic equation are: $\cos 20^\circ - \cos 40^\circ$, and $-\cos 80^\circ$. Required the equation.

624. *Proposed by J. Carl Kamplain, Student, Crane Junior College, Chicago.*

To determine a point such that its distances from the vertices of a given triangle are inversely proportional to the sides of the triangle opposite the respective vertices.

625. *Proposed by Clifford N. Mills, Brookings, So. Dak.*

If from the vertices of a triangle ABC, three straight lines, AA', BB', CC', are drawn to the opposite sides (or these sides produced), each equal to a given line, l, and from any point O within the triangle, Oa, Ob, Oc, are drawn parallel respectively to AA', BB', CC', and terminating in the same sides, then

$$Oa+Ob+Oc = l.$$

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, 10109 Wilbur Ave., S. E., Cleveland, Ohio.

Please send examination papers on any subject or from any source to the Editor of this department. He *will reciprocate by sending you such collections of questions as may interest you and be at his disposal.*

CONTRIBUTIONS.

Contributions of questions are gratefully acknowledged from P. M. Dysart, Schenley High School, Pittsburgh, Pa., and P. C. Hyde, Newark Academy, Newark, N. J.

Who will be the next to help?

Some of these papers will be published in a later issue of SCHOOL SCIENCE and MATHEMATICS.

QUESTIONS AND PROBLEMS FOR SOLUTION.

328. *Proposed to boys in The Warner & Swasey Apprentice School by Mr. Worcester R. Warner.*

The Panama Canal Locks at Gatun are in a series of three, each 1,000 feet long and 110 feet wide. Each of the three locks raises or lowers a ship 28 feet.

Gatun Lake is, therefore, 84 feet above sea level.

It is desired, first, to determine the quantity of water required to take each ship—one at a time—from the Caribbean Sea into Gatun Lake; and, second, the quantity of water required to return each ship—one at a time—from the lake to the Caribbean Sea again.

Answers are required in tons, computed by the following formula:

Cubic feet of water X .028 = tons.

Let us suppose a ship has just come down from Gatun Lake to the Caribbean Sea. The ships "A" and "B" are waiting to be taken from the sea to Gatun Lake, and back to the sea again, "B" to follow "A" in each direction.

Question 1: How much water must be taken from the lake to take "A" from the sea into the lake?

Question 2: How much water must be taken from the lake to take "B" from the sea into the lake?

Question 3: How much water must be taken from the lake to take "A" from the lake to the sea?

Question 4: How much water must be taken from the lake to take "B" from the lake to the sea?

The displacement of these ships is 35,000 tons each.

329. *Proposed by Earl R. Glenn, Lincoln School, New York City.*

Would it be possible to devise a new type of test, of the kind used in the army, say, as a partial substitute for questions on the College Entrance Examination Board list?

SOLUTIONS AND ANSWERS.

314. Are teachers and pupils satisfied with the questions asked on college entrance examinations in physics, especially Board examinations?

Here is your chance to offer suggestions.

"Is there anything to be said about the comprehensive physics, or chemistry, papers of the College Entrance Board? In the absence of any criticisms or suggestions from teachers in active service, the Board will be justified in considering that the papers are satisfactory. Speak up, gentlemen.—[Signed: John C. Packard, Brookline, Mass., member of Committee on Revision."

In answer to the above, propose questions, or a series of questions, such as the Board *ought* to use.

319. (*a*) Would the use of such a set of questions—which is plainly simpler than those of the College Board—be as satisfactory as the longer and more rigid questions now seen on those examinations?

(*b*) Is there sufficient stress laid upon:

(1) Practical processes. If not, what additions?

(2) Problems. Are the problems of the right kind?

(3) Equations. Has sufficient stress been laid on equations?

Note on 314 and 315.

No direct answers have been received, but Mr. Packard was asked Question 329 above as a result of the question. Please note also answer to 326 following.

315. *Proposed by James C. McClymont, Chester, Pa.*

How much power is developed by a man who weighs 160 pounds, walking on a level cement pavement for a distance of 300 feet, in 30 seconds?

Solution by an anonymous contributor.

Power = $(w \times \text{space})/\text{time}$

$= (160 \times 300)/30 = 1600$ ft. lbs.

H. Power = $1600/550 = 32/11 = 2.9+$.

Objection by A. Haven Smith, Riverside, Cal.

The answer to Problem 315 published in the May number of SCHOOL SCIENCE and MATHEMATICS is incorrect. There is not sufficient data given to solve the problem. A man walking on the level does not exert a force equal to his own weight. This would be done only when he is climbing vertically. The actual force exerted in this case is not given and I know of no practical way of determining it.

326. *Proposed by the Editor.*

What is the proper relation between practical questions, and theoretical and book questions on an examination paper?

For instance, on the examination papers which follow, **Physics A** is reckoned *theoretical* except the last part of 1, and the last part of 6 which are *practical*, and **2b** which is *descriptive*. In **Physics B** the problems are *practical* (or imitations thereof).

Compare any 1918 examination paper with these papers of 1903 and express your opinion as to whether progress in question asking and examination making is indicated. If so, where?

Answered by P. C. Hyle, Newark Academy, Newark, N. J.

(*a*) "Book questions" may be decidedly practical, e. g., 1918: six of the inclosed—one of the most puzzling distinctions to the boys in the whole subject. It seems to me that theory in book work must be treated throughout as nothing else than the body of interpretations by which we are able to predict and control the practically useful facts. I am sure many physics problems are not "practical," and most of the theory *is*. Nearly all the problems on battery currents, for instance, are pure "bunk," because internal resistance is not a constant but a very erratic variable; and the conventional method of treating batteries is entirely misleading. The distinction between E. M. F. and terminal voltage is the primary practical fact about the use of both batteries and dynamos; which distinction I have not seen clearly made in any physics text or manual intended for a general high school course in physics.

(*b*) As to progress in examination questions, it seems to me that there has been a marked tendency in just the direction indicated above, barring a few freak questions now and then. Princeton examinations were rather too much conventionalized for a first-class test; my file of old Princeton papers covering ten or twelve years shows nearly as much recurrence as the periodic table. The trigonometry involved in B2 and 6 of the 1903 paper was later dropped.

(*c*) To sum up in a sentence, an examination should be practical throughout—questions and problems both; the relative number of questions and problems is not of very great importance when theory is taught so as to show how it so greatly simplifies practical computation.

ARTICLES IN CURRENT PERIODICALS.

Literary Digest, for July 19; *New York City; $4.00 per year, 10 cents a copy*: "How the Press Answer the President's Plea"; "Future of Transatlantic Flight"; "Music Cure for the Wounded"; "Millions for Music"; for July 26: "The Menace of a Food Trust"; "Congress Sidetracking Aviation"; "Who Won the War?" August 1: "Parachuting from a Plane"; "Roads Past the Talking Stage"; "More Wheat with Tractors"; "The Cavalry of Industry"; "Single-Eyedness"; "Shooting Up Warehouses"; "Pontoon Railway Bridges"; "Odd Uses for Cloth"; "What the Draft Should Teach Us"; August 9: "The Hun as a Railroad-Wrecker"; "Air-Ships as Sanatoriums"; "Cylinders of Window-Glass"; "Draining the Everglades"; "Fires Started by Wireless"; "Branches and Roots by Turns"; "Objections to the Snake."

Photo-Era, for July; *Boston. Mass.; $2.00 per year. 20 cents a copy*: "The Sun and Moon in Photography," Carl J. Coe; "Data?" William Ludlum; "Hawaiian Notes," Herbert B. Turner; "Photography in the Tropics," F. Weston; "What is a Perfect Negative?" Rajar, Limited; "Development of Jena-Optical Glass," Wilfred A. French; "Fog-Photography," Beatrice B. Bell; "Practical and Humorous Experiences in Photography—Part V," A. H. Beardsley; "A Question of Photographic Hygiene," British Journal; for August: "The Photographic Guild of Baltimore," Donald McKendrie; "Architectural Traditions for the Photographer," Edward Lee Harrison; "The Permanency of Photographic Prints," The British Journal; "An Effort," Edgar A. Cohen; "Practical and Humorous Experiences in Photography. Part VI, A. H. Beardsley; "Woodland-Scenery," William S. Davis.

National Geographic Magazine, for July; *Washington, D. C.; $2.50 per year*: "The Progressive World Struggle of the Jews for Civil Equality" (15 illustrations), William Howard Taft; "Exploring Unknown Corners of the Hermit Kingdom" (31 illustrations), Roy C. Andrews; "Masters of Flight"; "A Hunter of Plants" (18 illustrations), David Fairchild; "The Land of Lambskins" (15 illustrations); Robert K. Nabours.

Physical Review, for July; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy*: "The Measurement of Heat and the Scope of Carnot's Principle," Arthur C. Lunn; "The Size and Shape of the Electron," Arthur H. Compton; "A Furnace Temperature Regulator," Walter P. White and Leason H. Adams; "The Variation in Sound Intensity of Resonators and Organ Pipes with Blowing Pressure," Beryl F. Love and Margaret K. Dawson; "The Distribution of Energy in the Spectrum of Erbium Oxide," W. S. Mallory; "On the Relation between the K Series and the L Series of X-Rays," William Duane and Takeo Shimizu; "The Velocity of Sound and the Ratio of the Specific Heats for Air," T. C. Hebb.

Popular Science Monthly, for August; *New York City; $3.00 per year, 20 cents a copy*: "Mapping the Earth from the Sky," James Prentice; "How Hot or How Cold is the Air?" "How the Airplane is Increasing Its Speed"; "Doubling Niagara's Leap," P. Schwarzbach; "Laying Out Airways and Terminals That Will Open Up the Skies to Commerce"; "The Momentous Vacuum Valve."

Review of Reviews, for July; *New York City; $4.00 per year, 35 cents a copy*: "My Five Months in France," Frank H. Simmonds; "Political and Economic Conditions in Europe," Frank A. Vanderlip; "The Railway Problem," Albert B. Cummins; "Is England's Friendship Worth While?" Frank Dilnot; "Making America Over," William E. Smythe; "Oil: The New Business Giant," Albert W. Atwood; "The Peace Treaty and the European Outlook," Frank H. Simonds; "The Figures of Our War Effort," Herbert T. Wade; "Reconstruction Needs of France," C. W. A. Veditz; "Forests of France and England," Elbert Francis Baldwin; "Porto Rico's Food Commission," Sylvester Baxter; "Canada's Immigration Law," Owen E. McGillicuddy; "War Service of Historians," Joseph Schafer; "A University's Recognition of Leadership."

School Science Review, for June; *Albemarle Street, London, W.; two shillings net*: "Ions in Solution," R. G. Durrant, Marlborough College; "Research Work in Schools," J. S. Hough, B. Sc., Oundle School; "Re-

cent Advances in Chemistry," T. Hart-Smith, A. R. C. S., F. I. C., County Secondary School, Battersea.

Scientific Monthly, for August; *Garrison, N. Y.; $3.00 per year, 30 cents a copy*: "Fortunes in Waste and Fortunes in Fish," Dr. Victor E. Shelford; "Our Iron-Clad Civilization," R. H. Whitbeck; "The Upper Cretaceous Mississippi Gulf," Edward W. Berry; "Man and His Nervous System in the War," F. H. Pike; "Two Southern Botanists and the Civil War," Neil E. Stevens; "William Ramsay," Dr. Benjamin Harrow; "A Possible New Source of Food Supply," P. W. Claassen.

THE ROOSEVELT MEMORIAL CAMPAIGN.

Immediately after the death of Theodore Roosevelt, there sprang up all over the country a demand for a memorial to this ardent patriot and great man, a memorial to express the affection in which he was held and to perpetuate for the benefit of future generations the ideas and ideals for which he stood.

The result of this demand was the formation of the Roosevelt Memorial Association, with headquarters at 1 Madison Avenue, New York City, a non-partisan organization in the creation of which personal friends of the late ex-President took the lead. This Association met in March and decided by formal vote to conduct a campaign to raise $10,000,000 by popular subscription, to erect in Washingron a national memorial monument; and to create at Oyster Bay, his home for so many years, a park which may ultimately include his estate of Sagamore Hill, to be preserved like Mount Vernon and the Lincoln home at Springfield.

Out of the thousands of suggestions for fitting memorials that came from Roosevelt's friends and admirers, it seemed that these two forms were most nearly significant of his life and personality. Washington, the capital of the country, where Roosevelt had spent so many of his years in work that left its impress on the history of the nation, could be left out of no plan for a permanent memorial to him. There is the most appropriate setting for a lasting tribute to him as a statesman and leader and servant of his fellow-countrymen.

Equally fitting for a memorial to Roosevelt as a man and as a lover of nature is the scene of his ideally happy home life at Oyster Bay. In his lifetime he loved it all, its woods and fields, the shores of Long Island Sound, the flowers and the birds. He loved the outdoor life, and he wanted others to love and share and benefit by it. During his lifetime, in fact, he endeavored to obtain an outdoor park for his friends and neighbors at Oyster Bay, but did not live to see the accomplishment of his wish. With his passing, a wider significance will be given to this cherished aim of his. The creation of a park will give his fellow-citizens opportunity for rest and recreation and upbuilding of mind and body; the inclusion of his home, with itsfields and woodlands, its furnishings, its library and trophies and gifts from all over the world, will make it particularly a spot associated with his memory and a Mecca for all Americans.

The Association is strictly non-partisan, for its purpose is to honor the memory of Theodore Roosevelt as a great American. So it is the earnest desire and hope of its members to enlist the cooperation of every American in this tribute of appreciation to Roosevelt as a man, a citizen and a patriot.

The campaign for the fund to establish the memorial will be held in every state during the week of October 20-27, and will be directed from the offices of the Association, at 1 Madison Avenue, New York. Organizations have already been completed in all the states and in the various subdivisions in which the canvass for subscriptions to the memorial will be made.

Every penny subscribed for the memorial fund will go into the fund, as generous personal friends of Colonel Roosevelt have undertaken to defray all the expenses incidental to the campaign. It is the hope of the Association that the number of contributors to the fund will be a gratifying index of the hold he had on the affections of Americans, North and South and East and West.

THE THEOREM OF NICHOMACHUS.

By U. P. Davis.

On page 463 of the May, 1919, issue of School Science and Mathematics, mention is made of the theorem first stated by Nichomachus that cubical numbers are sums of consecutive odd integers, and the writer of the article in question draws some very interesting conclusions in connection. Without doubt the study of the history of mathematics is of very great benefit to the mathematician in original investigation, but many times too much importance is attached to rather trivial conclusions of the ancient writers. This so-called "theorem" is indeed without foundation as a mathematical principle, and the student of history is compelled in common charity to believe that Nichomachus attached no importance to it as such.

It is readily seen that there is no connection between the fact that 64 is the cube of 4, and the fact that 64 is equal to the sum of 4 consecutive odd integers: 13, 15, 17, 19. This relation is true merely because 64 is the product of 4 and a certain other *even* factor. The fourth power of 4 is equal to the sum of 4 consecutive odd integers, not because it is a fourth power or any other power, but because 256 is the product of 4 and another *even* factor. The fifth power of 3 is equal to the sum of three consecutive *odd* integers simply because this number is the product of three and another *odd* factor.

The interesting theorem that "Any power of an integer is expressible as a sum of consecutive odd integers" is therefore only a half-truth. The principle might be stated a little more accurately as follows:

(a) The product of two *even* factors may be expressed as the sum of an *even* number of consecutive *odd* integers; (b) the product of two *odd* factors may be expressed as the sum of an *odd* number of consecutive *odd* integers; (c) the product of an *even* and an *odd* factor may be expressed as the sum of consecutive *even* integers. Thus: (a) $4\times6=3+5+7+9$; (b) $5\times7=3+5+7+9+11$; (c) $5\times8=4+6+8+10+12$.

No elaborate calculations are necessary to select the addends for these results in any given case, for one of the factors indicates the number of addends, and the other, the average of them. This is in short the process employed in determining the terms of the series in the extension of the theorem of Nichomachus above referred to.

REAL WAR TROPHIES FOR SCHOOL CHILDREN.

Banks of the Seventh Federal Reserve District are sending in rush orders for the hand grenade banks which the War Savings organization of the Seventh Federal Reserve District is going to distribute through the banks to the school children this fall.

Under the scheme adopted by the banks, they will "lend" a grenade bank to any child under seventeen years old who applies for it. To secure ownership of the grenade bank the child will be required to earn enough money to purchase one War Savings Stamp, if under ten years, and two if older, and take the money to the institution where the grenade bank was secured and buy a War Savings Stamp there.

For nearly five hundred years the military forces of the world have been developing the hand grenade as an engine of death and destruction. It remained for America to transform this ancient weapon into a peaceful constructive agency in the fight for thrift and individual saving.

The hand grenades, which are the highest development of the time-honored weapon, are transformed into thrift agencies by the simple process of clearing out the explosive chamber, cutting a slot through the shrapnel casting, which is the body of the grenade, and substituting a removable screw for the base of the casting. The grenade bank will hold one hundred pennies or one hundred dimes. With the exception of these changes the grenades remain in the exact form designed for their original purpose. Across the face of the grenade bank appear the words "Buy W. S. S."

This grenade is the modern successor of the first flasks filled with gunpowder which were used in 1427 in the defense of Casalmaggiore. From that time until the eighteenth century all armies experimented with various forms of grenades, made of heavy glass or metal.

During the reign of Louis XIV in France, the picked corps of soldiers assigned to the dangerous and difficult task of handling the grenade in battle acquired the distinctive title of grenadiers, from the "grenadiere," a large pocket in which they carried their weapon. During the Napoleonic wars the grenade fell into disuse, but Napoleon's Grenadiers of the Guard were his bravest and most faithful soldiers. The title of Grenadiers was perpetuated in the names of many regiments in various European armies.

The grenade was revived during the nineteenth century. Its real revival, however, came with the siege of Port Arthur in 1904, and every army was experimenting with the grenade when the trench warfare in the great World War forced it into action in earnest. Grenades of all kinds were developed among the British, French and German armies, but the most effective was the British form, the Mills hand bomb, which the average soldier could throw 100 feet or more from a trench. The hand bomb formed the basis for the American "defensive" grenade which has now been directed against the trenches of waste.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

Chicago, September 1, 1919.

Fellow Associationer:

"If satisfied, tell others; if not, tell us." This sign was seen in a shop a few years ago. Why not adopt that as our motto this year for the Association?

It is the exceptional individual who will not invest in what he knows will pay good dividends. The superintendent of a small city was approached by two of his principals with the request that he aid them in securing an increase in salary. They called attention to the discrepancy between their salaries and his. He acknowledged the discrepancy, but reminded them that while they had been investing their incomes in property, he had put his into further education, and he was then beginning to realize on his investment. *An investment in professional training pays these days.*

Do you question whether an investment in membership in the Central Association of Science and Mathematics Teachers is a good investment? Over 1,200 teachers of science and mathematics—college, normal, high school, and junior high school—are now on the rolls, many of them attending the annual sessions at Thanksgiving time and all of them receiving SCHOOL SCIENCE AND MATHEMATICS.

Committees are now busy in each section—Mathematics, Physics, Chemistry, Earth Science, Biology, General Science and Home Economics—formulating the principles of our new reconstruction period. We all want to "be in" on this program, and remember that the greater our investment of time and energy, the greater will be our dividends.

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BOOKS RECEIVED.

Committee on Education and Special Training, a Review of Its Work During 1918, by the Advisory Board. 144 pages. 20.5x26.5 cm. Paper, 1919. War Department, Washington.

The Winston Simplified Dictionary, by William D. Lewis, Principal William Penn High School, Philadelphia, and Edgar A. Singer, University of Pennsylvania. Pages xxii+820. 14x19 cm. Cloth, 1919. John C. Winston Company, Philadelphia.

Notes on Qualitative Analysis, by Louis A. Test and H. M. McLaughlin, Iowa State College. Pages vi+92. 13.5x20 cm. Cloth, 1919. 80 cents. Ginn & Company, Boston.

Engineering Application of Higher Mathematics, by V. Karapeloff, Cornell University. Four Parts, all 14x21 cm. Cloth. 75 cents each. Part II, pages v+101. Part III, pages v+112. Part IV, pages v+79. Part V, pages vi+64. John Wiley & Sons, New York City.

Teachers' Manual, First Course in Algebra, by Walter B. Ford, University of Michigan, and Charles Aimmerman, McKinley High School, St. Louis. 341 pages. 13x19 cm. Board, 1919. The Macmillan Company, New York City.

Higher Arithmetic, by George Wentworth and David E. Smith. Pages v+250. 13x19 cm. Cloth, 1919. $1.00. Ginn & Company, Boston.

Food Saving and Sharing, by the United States Food Administration. Pages x+102. 13x20 cm. Board, 1919. Doubleday, Page & Company, New York City.

What the War Teaches About Education, by Ernest C. Moore. 334 pages. 13.5x19.5 cm. Cloth, 1919. $1.20. The Macmillan Company, New York City.

Applied Calculus, by Robert G. Thomas, Military College of South Carolina. Pages xviii+490. 13x19 cm. Cloth, 1919. $3.00. D. Van Nostrand Company, New York City.

Junior High School Mathematics, by William L. Vosburgh, Boston Normal School, and Frederick W. Gentleman, Mechanics Arts High School, Boston. Pages ix+295. 13x19 cm. Cloth, 1919. The Macmillan Company, New York.

College Algebra, by H. L. Rietz, University of Iowa, and A. R. Crathorus, University of Illinois. Pages xiii+268. 13x20 cm. Cloth, 1919. Henry Holt & Company, New York City.

Complete School Algebra, by Herbert E. Hawkes, Columbia University,

William A. Laby, Kansas City Polytechnic Institute, and Frank C. Lawton, High School, St. Joseph, Mo. Pages ix+507. 13x18.5 cm. Cloth, 1919. $1.40. Ginn & Company, Boston.

Thrift and Conservation, How to Teach It, by Arthur H. Chamberlain and James F. Chamberlain. 272 pages. 12.5x19.5 cm. Cloth, 1919. $1.40 net. J. B. Lippincott Company, Philadelphia, Pa.

The Blind, Their Condition and the Work Being Done for Them in the United States, by Harry Bert. Pages xxviii+763. 13.5x20 cm. Cloth, 1919. The Macmillan Company, New York City.

Vocational Agricultural Education, by Rufus W. Mimson, State Supervisor of Vocational Agricultural Education, Mass. Pages xxxviii+468. 14x20 cm. Cloth, 1919. $2.50. The Macmillan Company, New York City.

Textiles and Clothing, by Ellen B. McGowan, Teachers College, Columbia University, and Charlotte A. Waite, Julia Richman High School, New York City. 268 pages. 13x19 cm. Cloth, 1919. The Macmillan Company, New York City.

Vocational Civics, by Frederic M. Giles, De Kalb, Ill., High School, and Imogene K. Giles, J. Sterling Morton High School, Cicero, Ill. Pages x+252. 13.5x19 cm. Cloth, 1919. $1.30. The Macmillan Company, New York City.

The Realities of Modern Science, by John Mills, Western Electric Laboratories. Pages xi+327. 14x20.5 cm. Cloth, 1919. $2.00. The Macmillian Company, New York City.

A History of Mathematics, by Florian Cajori, Second Edition, Revised and Enlarged, University of California. Pages viii+514. 13x22 cm. Cloth, 1919. The Macmillian Company, New York City.

An Educational Study of Alabama. 522 pages. 14.5x23 cm. Paper, 1919. Government Printing Office, Washington.

Hamilton's Essentials of Arithmetic, First and Second Books, by Samuel Hamilton, Superintendent of Schools, Alleghany County, Pa. First book, 368 pages. Second book, pages 428+xxvii. 13.5x18 cm. Cloth, 1919. American Book Company, New York City.

Plant Production, Agronomy, and Horticulture, by Ransom A. Moore, University of Wisconsin, and Charles P. Holligan, Michigan's Agricultural College. 428 pages. 13.5x19 cm. Cloth, 1919. American Book Company, New York City.

The Carnegie Foundation for the Advancement of Teaching, Thirteenth Annual Report of the President and Treasurer. Pages vi+162. 19 x 25.5 cm. Paper, 1918. 576 Fifth Ave., New York City.

The Fundamentals of Citizenship, by National Catholic War Council Committee. 92 pages. 13x20 cm. Paper, 1919. 1312 Massachusetts Ave., Washington, D. C.

Induction Costs in Theory and Practice, by F. E. Austin, Hanover, N. H. 64 pages. 14x22 cm. Cloth, 1919. $1.00. Box 441, Hanover, N. H.

First Course in Algebra, by Walter B. Ford, University of Michigan, and Charles Ammerman, McKinley High School, St. Louis. Pages xiii+334. 13x19 cm. Cloth, 1919. $1.20. The Macmillan Company, New York City.

Junior High School Mathematics, Second Book, by E. H. Taylor and Fiske Allen, Eastern Illinois Normal School, Charleston, Ill. Pages ix+251. 13x19 cm. Cloth, 1919. Henry Holt & Company, New York City.

Intermediate Textbook of Chemistry, by Alexander Smith, Columbia University. Pages vi+520. 14x20.5 cm. Cloth, 1919. $2.25. The Century Company, New York City.

BOOK REVIEWS.

The Winston Simplified Dictionary, by William D. Lewis, Principal William Penn High School, Philadelphia, and Edgar A. Singer, University of Pennsylvania. Pages xxii+820. 14x19 cm. Cloth. 1919. John C. Winston Company, Philadelphia.

A dictionary which has been made to meet a real need by all teachers as well as the general public. It is a book which cannot help appeal to all persons who desire to know quickly the meaning and pronunciation of any word now used in the English language. It will cause pupils especially to get the dictionary habit and thus become more proficient in the correct use of words, but will at the same time increase their vocabulary. This book will give the person the right information at a glance, and thus not discourage him in his efforts to determine the correct meaning of words. The writer has been wonderfully surprised and pleased with the remarkably clear and concise definitions of words which he has had occasion to look up. One is not left in the dark, but finds that which he wants. One dictionary might be mentioned where the meaning of *inconsistency* is given as *incongruity*, and where *incongruity* is made to mean *inconsistency*, no further explanation being given. Not so with this book, as one gets a clear meaning of each word. The definition of each word is complete in itself. A great number of words are best understood by their use in real sentences. For this reason this book gives thousands of illustrative sentences and phrases.

Pictorial illustrations are made to help in the definition of many words by the more than frequent use of wisely selected pictures of objects.

The pronunciation of words is given by a phonetic respelling of the word with diacritical markings. A key to further help in pronouncing is given at the bottom of each page.

The vocabulary is large, particular attention being given to words of recent origin and meaning in science, history, and civics, and to those words which have recently come into use through the great war. There are many new and special features. There is a chapter on "How Our Language Has Grown," which is of the greatest value to every student. Simple rules for spelling are given, and also a guide to pronunciation. 730 pages are given to the dictionary of the English language. All words defined are printed in heavy, bold face type. A dictionary of Mythological and Classical names of 14 pages is given as an appendix, also one on foreign words and phrases. Names of places are given splendid treatment, too.

This is a book which ought to be in every schoolroom and home of our land. It deserves, and doubtless will have, a very extensive sale. The technical work on the book is as near perfect as is possible. C. H. S.

Our Trees: How to Know Them (New Revised Edition), by Arthur I. Emerson and Clarence M. Weed. 19x25 cm. 295 pages. 149 illustrations. J. B. Lippencott Co., Philadelphia, Pa. $3.50 net.

About twenty pages of new material have been added to the new edition of this standard work on the trees of America.

The new introductory material for *Our Trees* begins by telling of the general characteristics of the different kinds and how they change in summer, autumn, winter, and spring, why they drop their leaves, how they prepare their flower and leaf buds for new growth. It explains how to distinguish each species at a glance at any season of the year, and it gives a description of the rarer trees imported for forest use or on account of beauty of flower or form, including conifers and those with colored foliage. The

relative usefulness of important species for street, garden, small park, and woodland planting is also given.

The pictures have in all cases been photographed direct from nature, and have been brought together in such a way that the nonbotanical reader can recognize at a glance either the whole tree or the leaves, flowers, fruits, or winter twigs, and thus be able to identify any unknown tree to which his attention may be called. A plate is devoted to each tree, showing the tree itself, its foliage, bloom, and fruit.

Our Trees should be in every botanical laboratory. There is no book published at near the price that can compare with it. C. M. T.

Junior High School Mathematics, First Book, by E. H. Taylor, Ph.D., Instructor in Mathematics, and Fiske Allen, A.M., Principal of the Training School, Eastern Illinois State Normal School. Pages ix + 210. 13×19 cm. 1919. Henry Holt and Co., New York.

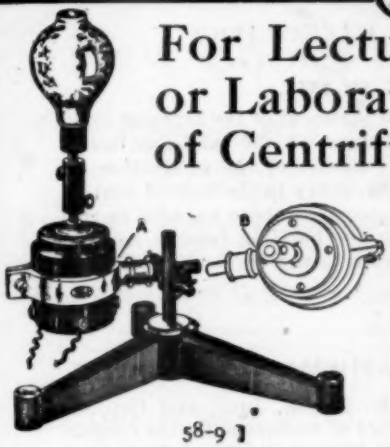
By omitting the more difficult and technical applications of arithmetic, considerable good work in algebra and geometry is given in these two books for the seventh and eighth grades. The *First Book* hardly seems to be an effort to combine these branches of mathematics. The topics selected appear quite naturally to be the kind of mathematics that children in these grades can and should understand. Much drill is furnished in the fundamental operations of arithmetic practice in the interpretation of problems, and a study of percentage and its application to common affairs. The constructive geometry is well planned to give not only a real understanding of geometric notions but also to give good work in drawing and arithmetical computations. H. E. C.

The Training of Teachers of Mathematics for the Secondary Schools of the Countries Represented in the International Commission on the Teaching of Mathematics, by R. C. Archibald, Associate Professor of Mathematics in Brown University. Bulletin, 1917, No. 27. Paper covers. Pages, 289.

This bulletin is based very largely upon facts from the reports to the International Commission of Mathematicians, and presents briefly the most important points from over 12,000 pages of reports. There are included also very brief independent sketches of the educational conditions in the various countries, which are intended to show the preparation of the secondary-school teacher for his duties and the type and caliber of men who take up such work. At present this bulletin may be obtained free upon application to the Commissioner of Education, Washington, D. C. H. E. C.

Introductory Mathematical Analysis, by W. Paul Webber, Ph.D., Assistant Professor of Mathematics in the University of Pittsburgh, and Louis C. Plant, M. Sc., Professor of Mathematics in Michigan Agricultural College. Pages, xiii + 304. 14×21 cm. 1919. John Wiley and Sons, Inc., New York.

This book contains the elements of college algebra, trigonometry, analytic geometry, and calculus correlated by topics and by emphasizing the function idea. The first two chapters give a brief outline of algebra and a number of geometry theorems for review or reference. Graphic representation and its uses are given considerable attention, and vectors are treated more fully than usual. Enough space is given to the principles of calculus so that the student can understand and use them. The derivative is used in solving problems in rates and maximum and minimum values, and integration is applied in finding areas, volumes, average values, work done by a variable force, and center of gravity of areas and solids. H. E. C.



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New High School Arithmetic, by Webster Wells, and Walter W. Hart, Assistant Professor of Mathematics, University of Wisconsin Course for the Training of Teachers. Pages, viii+358. 12×18 cm. 1919. D. C. Heath and Co., New York.

To furnish adequate material in one book for academic, industrial, and commercial courses in arithmetic is considerable of an undertaking, but it is certain that the numerous and varied topics give the teacher an opportunity of selecting the material adapted to the needs of pupils in various communities. The utility of a high school course in arithmetic is now fairly well recognized and many schools are making a place for it. This *Arithmetic*, modern and varied in its appeal because of the problem material drawn from current life, and sound in the principles and rules of teaching, should be examined by all teachers of high-school arithmetic.

H. E. C.

Elements of Plane Trigonometry, by Alfred M. Kenyon, Professor of Mathematics, Purdue University, and Louis Ingold, Assistant Professor of Mathematics, the University of Missouri. Pages ix+117+124. 13×20 cm. $1.20. 1919. The Macmillan Company, New York.

The writer used the authors' larger work on *Plane and Spherical Trigonometry* in his classes for several years with a good deal of satisfaction, and notes with interest the changes in this rewritten edition, which is intended to give a clear view of the immediate usefulness of trigonometry. Few students will feel the lack of a knowledge of the purely theoretical matter and traditional topics which have been omitted in this edition. The practical problems and applications and clear explanations of principles and processes make it a desirable book for technical students and for men who want to get a working knowledge of trigonometry in a short time. The tables are very complete and usable. The tables of powers-roots-reciprocals should be in every textbook of trigonometry. There is also published an edition, *Elements of Plane Trigonometry*, with brief tables, price $1.00. H. E. C.

SAND-LIME BRICK IN 1918.

The United States Geological Survey, Department of the Interior, now has ready for distribution its annual statement on the sand-lime brick industry in 1918. This report contains statistics of the production of sand-lime brick since the beginning of the industry in the United States, in 1903. It also contains information of interest to those engaged in the building industries and in the manufacture of building brick. A copy of the report may be obtained by application to the Director, U. S. Geological Survey, Washington, D. C.

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March, June, and October issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your Society listed here? Names are dropped when they become one year old.

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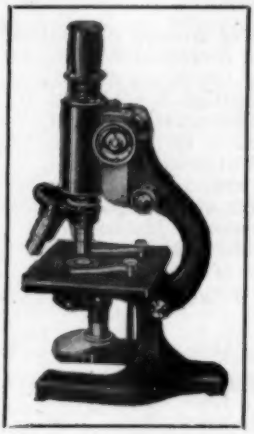

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